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TWO NEW MYRMECOPHILOUS GENERA OF ABERRANT PHORIDÆ FROM TEXAS.[1]

CHARLES THOMAS BRUES.

THE discovery of two new genera of myrmecophilous diptera allied to the Stethopathidæ, in Texas, is entirely unexpected. That a family of wingless Diptera hitherto represented by a small group of genera in the Old World should suddenly appear in North America is, to say the least, a very unusual occurrence.

The new genera are also very interesting from a taxonomic point of view, as they show very clearly the affinities of the Stethopathidæ and Phoridæ, which have hitherto appeared somewhat doubtful.

Last October, while collecting ants in one of the pecan groves upon the outskirts of Austin, Texas, Dr. Wheeler of the University of Texas found in a nest of *Solenopsis geminata* Fabr. several specimens of a peculiar dipteron with rudimentary wings. Upon closer examination they seemed to be Phoridæ, although their habitus was extremely like that of the Stethopathidæ, from which they were easily distinguished by their halteres and small wings.

[1] *Contributions from the Zoölogical Laboratory of the University of Texas*, No. 15.

About a month later Dr. Wheeler called my attention to a number of somewhat similar flies in a nest of *Eciton cæcum* Latr. which had been in the laboratory for some time. These also proved to be Phoridæ, but of a still more degenerate type.

A more careful examination has shown that these two genera are referable to the Stethopathidæ, but at the same time are evidently degenerate Phoridæ, so that the former family must be included in the Phoridæ. Such an addition does not make the family an incongruous one. When Loew (**'57**) placed his African Psyllomyia in the Phoridæ he made a statement equally applicable to the present addition:

"Wenn irgend etwas geeignet ist über die verwandtschaftlichen Beziehungen der Phoriden eine Aufklärung zu geben, so sind diess Arten, welche so sehr von dem Typus der in der alten Gattung *Phora* vereinigten abweichen, wie die oben beschriebene, und welche doch der Familie der Phoriden mit so bestimmt ausgesprochener Entschiedenheit angehören wie sie.

"Leider muss ich bekennen, dass die oft wiederholte Vergleichung der *Psyllomyia testacea* mit Diptern gar verschiedener Familien mir nach dieser Richtung hin durchaus kein positives Resultat gegeben hat, so dass ich die Familie der Phoriden von allen andern Familien der Diptern noch so scharf getrennt und so unvermittelt zwischen ihnen stehen sehe, wie zuvor."

With the discovery of the still more degenerate forms his remarks lose none of their pertinence.

The family Stethopathidæ was established by Wandolleck in 1898 (**'98b**) for the reception of several genera of Diptera which are remarkable for the total absence of wings and halteres, besides other less striking peculiarities. Two of the genera which he describes had been previously described by Dahl (**'97**) as sexes of a single species which he named *Puliciphora lucifera* and placed among the Phoridæ. He, however, considered at the same time that they were a connecting form between the Aphaniptera and Diptera and accordingly announced that he had solved the much-vexed question of the relation of the fleas with the Diptera.

Wandolleck later showed (**'98a**) that this idea is wholly erroneous as far as the Aphaniptera are concerned, and that

they are in no way related to them, nor, on the other hand, did he consider them to be Phoridæ.

His third genus, which he leaves without a name, had been previously named in his honor by Cook ('98).

The most important characters of the Stethopathidæ, as defined by Wandolleck, are the total absence of wings and halteres, the strongly reduced thorax, very small eyes, large coxæ, and small external genital organs of the female.[1]

Recently Wasmann has described a genus of termitophilous Diptera ('00a) which agrees with the Stethopathidæ in all essentials, except that they possess rudimentary wing-like appendages and a slightly larger thorax. These are characters that would not warrant the erection of another family for their reception. Moreover, the presence of rudimentary thoracic appendages places them still closer to the Phoridæ.

The two Texan genera approach the true Phoridæ even more closely, since one of them possesses both halteres and rudimentary wings, and both have the large macrochætæ of the body hairy, a character which Wasmann has pointed out as distinguishing the Stethopathidæ and Phoridæ. In both of these forms the abdomen is almost completely membranous. The African genus Psyllomia, however, has an abdomen of the true phorid type, while it agrees with one of the new genera, Commoptera, in having rudimentary wings, as well as in the structure of the head. The external sexual organs of the female are so clearly of the phorid type that they present no important deviation.

Through these forms we can pass without any great gaps from the Stethopathidæ to the Phoridæ, and as such is the case, *the family Stethopathidæ is certainly untenable, and the genera hitherto placed there, together with Psyllomyia and the*

[1] I have not considered the form of the mouth-parts in Wandolleck's three genera, which he believes to be entirely different from those of the Phoridæ and all other Diptera. He himself says, however, that Dahl, who has spent much time in studying the Phoridæ, considers them as phorid mouth-parts. He says: "Ich zeigte die Zeichnungen Dahl, der sich seit Jahren mit Phoriden beschäftigt, er erkannte sie sofort als Phoridenmundtheile an. . . ." I think Wandolleck must have exaggerated the extent and importance of the variation in the mouth-parts, for the two Texan genera have typical phorid mouth-parts, often, however, shrunken and distorted in alcoholic specimens.

two described below, had best be considered as the subfamily Stethopathinæ of the Phoridæ.

It does not seem probable that the forms have had a common origin however; even their distribution would preclude this in the case of such a recent group. On the other hand, there seem to be several independent lines of descent which we can to some extent suggest. In Psyllomyia the degeneration consists in the reduction of the eyes, absence of ocelli, and reduction of wings. In Commoptera the eyes are larger, the ocelli present; but the abdomen is extremely degenerate in structure, being almost wholly membranous. Ecitomyia could be more easily derived from forms like Commoptera, as it has very rudimentary wings, no halteres, smaller eyes, smaller thorax (without scutellum), and about equally degenerate abdomen. The degeneration has gone furthest in the genera from the Bismarck Archipelago and west Africa. Here the thorax is exceedingly small, the wings and halteres completely lost, the eyes very small, and the abdominal segments more or less membranous. Of these Stethopathus alone has retained distinct ocelli. Wasmann's Termitoxenia has the immensely swollen abdomen so characteristic of all termitophiles, and a greatly modified head. It does not approach closely to any of the other genera.

The following table, showing the order of degeneracy with regard to different structures in the genera of the Stethopathinæ as compared with Phora, will serve to emphasize the great disparity between the genera. *Phora* is placed at the top in each case and the most degenerate genus at the bottom.[1]

WINGS.	EYES AND OCELLI.	ABDOMEN.	THORAX.
Phora	Phora	Phora	Phora
Psyllomyia	Commoptera	Psyllomyia	Commoptera
Commoptera	Termitoxenia	Chonocephalus	Psyllomyia
Ecitomyia	Stethopathus	Stethopathus	Termitoxenia
Termitoxenia	Psyllomyia	Ecitomyia	Ecitomyia
Stethopathus	Wandolleckia	Commoptera	Stethopathus
Wandolleckia	Ecitomyia	Wandolleckia	Wandolleckia
Chonocephalus	Chonocephalus	Termitoxenia	Chonocephalus

[1] Where ocelli or wings are absent I have judged by the size of the eyes and the thorax.

Still more remarkable is Ænigmatias, represented by *Æ. blattoides* Meinert from Denmark, which does not seem to be closely related to the Stethopathinæ, although I have unfortunately not had access to the original description of Meinert ('90). Its habitus is certainly entirely different from that of any of the genera here mentioned. *Platyphora lubbockii* Verrall has been suggested as the possible male of Ænigmatias, but that is very problematical.

Throughout the winter we had been searching in vain for the males of Ecitomyia, which is very common in the nests of *Eciton cæcum*, but not until spring (February 3) were we able to obtain them. On that day we obtained two specimens from different nests in which the females were abundant. A glimpse at one of them immediately justified any surmises made as to their phorid character, for the males, although much like the females, possessed fully developed wings with the peculiar phorid venation and large halteres!

Such a remarkable amount of variation in usually stable morphological characters may be best explained by the great tendency of all degenerate structures to vary in an unusually high degree, and by a great power of adaptation in the Phoridæ.

The habits of only four of the genera are known with certainty. They are all myrmecophiles or termitophiles. A fifth, Wandolleckia, lives apparently ectoparasitically upon large west African land snails (*Achatina variegata* Roissy).

Their geographical distribution is extremely peculiar and is a case of remarkable discontinuous distribution not due to the great age of a certain type, for it does not seem possible to regard them as an old group, but rather as several independent and to some extent conveying lines of degeneration. This view is strengthened by the above-mentioned impossibility of showing any interrelation of the genera.

The following dichotomy will serve for the identification of the genera thus far known.

STETHOPATHINÆ.

Wingless or with rudimentary wings, eyes reduced, abdominal plates usually much reduced, coxæ very long, face deeply concave, eggs usually very large and causing an enlargement of the abdomen. Males, as far as positively known, easily correlated with the females, but much like the males of the Phorinæ.

GENERA OF STETHOPATHINÆ (FEMALES).[1]

1. Wings and halteres absent 5
   Either wings or halteres or both present 2
2. Both wings and halteres present, the former abbreviated . . 3
   Either wings or halteres present, never both 4
3. Arista of antenna dorsal, abdomen strongly chitinized throughout, proboscis much longer than height of head, very slender
   Psyllomyia Lw.
   Arista terminal, abdominal segments small, the greater part of the abdomen membranous, proboscis shorter than height of head, stout
   Commoptera *gen. nov.*
4. Abdomen greatly swollen, its apical segments bent forward on the ventral side of abdomen. Wings absent, halteres present
   Termitoxenia Wasmann
   Abdominal segments normal in position, wings present, halteres absent
   Ecitomyia *gen. nov.*
5. Ocelli present . . . . Stethopathus Wand.
   Ocelli absent 6
6. Head longer than wide, subtriangular, palpi when viewed from above extending far beyond anterior margin of head. Two macrochætæ on posterior margin of head . . . . Wandolleckia Cook
   Head wider than long, trapezoidal, palpi not extending forward beyond front margin of head . . . . . . Chonocephalus Wand.

If we desire to consider Ænigmatias as belonging here, it may be separated from all the other genera by its stout blattid-like form, with the thorax as wide as the abdomen. The problematical male (Platyphora) differs from the male of Ecitomyia in having no macrochætæ on the dorsum of the thorax.

[1] The male of only one genus (Ecitomyia) is known and it may be recognized by the diagnosis given farther on.

PSYLLOMYIA LOEW.

Head swollen, lentiform, completely chitinized. Eyes extremely small, somewhat wider than high, situated on the sides of the head. Ocelli absent. Antennæ two-jointed, only of medium size, each situated in a cavity, separated by the front margin of the head, which extends somewhat between them. Arista very thickly clothed with moderately long hairs. Palpi projecting, not very stout, bristly along the lower side and at the tip. Proboscis very long, geniculate, without distinct labellæ. Thorax rounded. Abdomen and legs as in Phora, the latter very bare, only at the tips of the four posterior tibiæ, with short, small bristles. Wings abbreviated, leathery, resting upon the dorsum of the abdomen and having the general appearance of short elytra (about as in Meloë). They have indications of three very thick, rib-like longitudinal veins, which are beset with small black bristles, some of which are noticeable because of their much greater length. Halteres beneath the wings, almost rudimentary.

Psyllomyia testacea Lw. (Fig. 1). Length 1.75 mm. Pale brownish yellow. Arista and wings, with the exception of the longitudinal veins, more yellowish white; the entire abdomen black. The entire upper side of the head finely punctured and covered with hardly perceptible hairs; besides these there are two posteriorly directed black macrochætæ on the extreme anterior part of the head, two anteriorly directed ones on each side close to the base of the proboscis, one anteriorly directed one immediately in front of the eye, and four posteriorly directed ones upon the occiput, close to the rather acute margin of the head. Thorax with scattered black bristles, one of especially large size on the side of the thorax at the upper part of the front coxa. On the wings two bristles are especially large, one of them on the inner margin, the other near the apex.

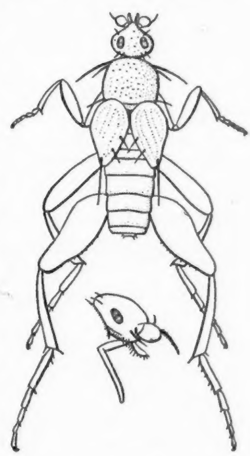

FIG. 1. — *Psyllomyia testacea* Lw., ♀. (After Loew.)

The specimens described by Loew were collected in Kaffir Land, Africa. Of all the genera this most closely resembles the Phorinæ, yet it shows undoubted affinities with Commoptera. The long proboscis is apparently quite different from those of the other genera.[1] The antennæ have a dorsal arista,

[1] Wasmann, however, mentions that Dorniphora Dahl, one of the Phorinæ, possesses a somewhat similar proboscis.

which is evidently homologous to the three apical joints in the antennæ of the other genera.[1] Such a variation in the insertion of the arista is seen also in the Phorinæ. The palpi and eyes are very small. The wings are shaped much as in Commoptera, but are almost free from bristles along the costa. The legs are of the usual phorid type, and judging from the figure the coxæ must be exceedingly lengthened.

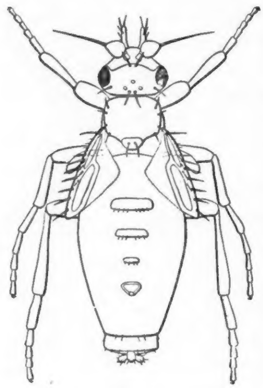

FIG. 2. — *Commoptera solenopsidis*, n. sp. Female, dorsal view.

Nothing whatever was known by Loew of the habits of this peculiar form, but Wasmann has mentioned it ('00b) as the guest of a south African doryline ant (*Dorylus helvolus* Linn.). He also includes in his list of the guests of the South-American *Eciton predator* "Phorid *N.G. n. sp.* (prope *P. testacea* Lw.), *S. Catharina*."

COMMOPTERA SOLENOPSIDIS (*gen. et sp. nov.*).

Female (Figs. 2 and 3). Length 1.5 mm. Abdomen 1.01 mm. Thorax .26 mm. Head .45 mm. Halteres .19 mm. Pale yellow, head somewhat darker, and abdomen somewhat lighter, legs concolorous with thorax. Body everywhere more or less covered with fine hairs. Head, seen from the side, oval. Vertex gently descending, about two-thirds as long as the mesonotum; face as long as the mesonotum, the antennæ inserted low down close to the mouth, in elongate vertical depressions which are quite shallow. Antennæ of the usual form, arista terminal, strongly pubescent. Eyes oval, one-half as high as the head and two-thirds as wide as high, with the ommatidia separated and convex. They are

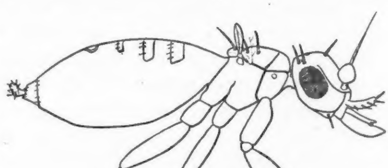

FIG. 3. — *Commoptera solenopsidis*, n. sp. Female, side view.

[1] Wandolleck speaks of them as antennal joints, but such a nomenclature seems inconsistent with the one usually adopted.

placed slightly above the middle of the head. Ocelli large and well developed, occupying their usual position in a triangle upon the vertex. Palpi as long as eye, small and slender, with the usual macrochætæ which are also smaller. Proboscis two-thirds as long as head, stout and thick (Fig. 4). Cheeks each with a large, downwardly directed macrochæta. A pair of closely approximated, anteriorly directed bristles on anterior margin of front; another posteriorly directed pair on the posterior margin of the head; and a third outwardly directed pair near the posterio-lateral corners of the head. Mesonotum somewhat wider than long, with four outwardly directed marginal macrochætæ on each side. Scutellum small, convex, much rounded behind, less so in front, projecting somewhat over the metathorax behind, with a pair of strong approximated median macrochætæ. Posterior part of metathorax produced back into the abdomen like a very large scutellum. Seen from the side the thorax is oval, not much larger than the head. The anterior coxæ are exceedingly large and freely movable. The other coxæ smaller, more or less connate with the thorax, the hind pair extending back beneath the base of the abdomen. Prothoracic stigma large and distinct. Wings short, less than one-third as long as the body, rather narrow and pointed, subtriangular in outline (Fig. 5). Along the costa are two rows of stout macrochætæ; elsewhere the wings are covered with fine, short hairs. Veins not sharply distinguishable from the surrounding membrane, consisting of two longitudinal veins which coalesce at the tip of the wing. Toward the base of the wing the first furcates, as does also the second. The anterior branch of the second vein unites with the posterior branch of the first. Posterior branch of second vein evanescent. Two vestigial posterior veins are present also. Halteres immediately behind the wings large, consisting of three distinct joints, the basal two small, quadrate; the third, large, stout, oval (Fig. 5). The third joint is almost as large as the palpi and flattened behind, so that a sharp edge separates the plane part from the remainder of the joint. Abdomen elongate oval, somewhat depressed, finely hairy, membranous except for the small dorsal plates, which are extremely rudimental. The first is a wide band, extending only one-third

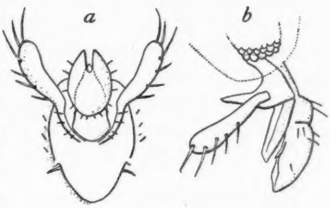

FIG. 4. — Mouth-parts of *Commoptera solenopsidis*, n. sp. *a*, ventral view; *b*, lateral view.

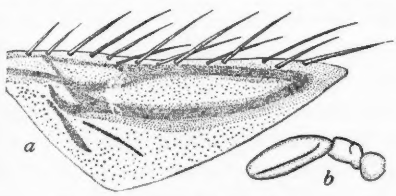

FIG. 5. — *Commoptera solenopsidis*, n. sp. *a*, wing; *b*, halter.

across the abdomen; the second, four times as wide as long, oval; the third, similar and much smaller; fourth, triangular, with a large pit in the center. Sexual organs of the usual form. The central axis is broadly rounded and bisetose at tip; lamellæ short, club-shaped, and rounded at the tips, quite bristly. Last two abdominal segments with rows of marginal bristles. The last two segments of the abdomen are retractile, as in Ecitomyia, and capable of being exserted to a considerable extent. Legs moderately stout. Hind metatarsi flattened, and with regular rows of transverse macrochætæ.

Three female specimens found in a nest of *Solenopsis geminata* Fabr., at Austin, Texas, Oct. 24, 1900, by Dr. Wm. M. Wheeler.

The structure of Commoptera is on the whole more degenerate than that of Psyllomyia. The eyes are larger and the ocelli present, but the swollen membranous abdomen and general habitus are at least a greater departure from the phorid type, if not a mark of degeneracy.

The head and its appendages are much as in the genera described by Wandolleck. The eyes are, however, less reduced and the ocelli nearly of normal size. A most remarkable difference is seen in the proboscis, which is not long as in Psyllomyia. The mouth-parts do not differ to any extent from those of some Phoras which I have examined.

The thorax and its appendages present nothing new, except the peculiar condition of the wings. At first I thought it possible that the wings were normally of the usual size and had been bitten off around the edges. But this view is disproved by two facts. In the first place, the wings are symmetrical and have the edges perfectly continuous. In only two wings (out of six) did there seem to be any irregular or notched places along the posterior margin. Secondly, the extreme activity of the flies would make it impossible for the Solenopsis, although it is quite an active ant, to gnaw off the wings so as to present even a semblance of the perfect symmetry exhibited. We are then forced to conclude that such abortion is natural and that the wings have been decreased in size on account of the inconvenience they presented to the fly while moving about in the galleries of the Solenopsis nest. Wings would indeed be a great inconvenience in moving about in the narrow galleries and quite an unnecessary burden, when the legs are adapted to such wonderfully quick motions.

The condition of the abdomen is also remarkable. The segments have no doubt been reduced, independently of the secondary swollen condition due to the immense eggs. Such small abdominal plates fitted together in their normal position would form an abdomen so utterly at variance with the size required to perform its natural functions that we must consider the segments reduced and the abdomen also enlarged, probably by post-metamorphic growth. The difference in the size of the abdomen in different specimens of Ecitomyia shows that a considerable post-metamorphic enlargement occurs in that species. The external sexual organs do not depart from those of Phora, except that they may be slightly reduced in size. The fourth abdominal segment differs from all the others in having not a dorsal plate, but a chitinous ring, triangular in shape and surrounding a membranous patch which probably has a glandular function.[1]

There can be no doubt that this peculiar insect is a true myrmecophile, as the nest in which they were found contained numerous individuals, most of which escaped on account of their extreme activity. Although we have examined a great number of similar Solenopsis nests, we have seen no other specimens, so that, in this locality at least, it is much rarer than the genus living with Eciton.[2]

ECITOMYIA WHEELERI *gen. et sp. nov.*

Female (Figs. 6 and 7). Length 1.20 mm. Abdomen .93 mm. Thorax .16 mm. Head .14 mm. Wings .14 mm. Head and thorax yellowish brown, much darkened above. Abdomen yellowish white, its small dorsal plates darker, the first almost piceous. Legs concolorous with the lower portions of the thorax. Head, seen from the side, subtrapezoidal, the front gradually descending, nearly as long as the dorsum of the thorax. Height of antennal cavity about equal to the front, about one-third as deep as high, regularly arcuate. The antennæ (Fig. 8) arising near the base of the cavity, of typical form : first joint small ; second, large globose, obtusely pointed at tip ; first joint of arista small, distinct ; second, longer ; third, nearly equal

[1] Owing to the limited number of specimens which we have of this species, I could not examine its structure. It is no doubt similar to the one described at length under Ecitomyia.

[2] Since writing the above, I captured another specimen in a nest of the same ant (April 6th).

to first and second together; the terminal slender portion not very distinct from the third joint, distinctly plumose. Eyes slightly smaller than second antennal joint, oval, with about twenty facets. Palpi rather slender, arcuate near base, as long as the front, bearing six strong macrochætæ laterally and a few other weaker ones. All of them, especially the larger ones, distinctly and finely hairy.

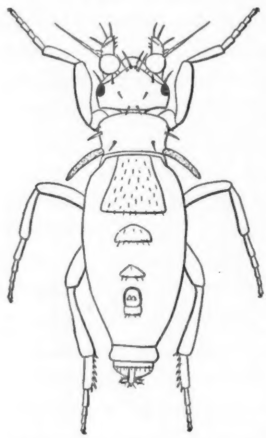

FIG. 6.—*Ecitomyia wheeleri*, n. sp. Female, dorsal view.

Thorax smaller than the head when viewed from the side and longer than high, the suture between the pro- and mesothorax distinct above on the pleuræ, prothoracic stigma distinct (Fig. 9, *d*). Mesopleuræ distinctly hexagonally areolated below. Wings a little longer than the thorax, slender, flat, and obtusely pointed at tip; covered on the dorsal side with short bristly hairs. Dorsum with six macrochætæ: two small humeral, two larger post-humeral, and two widely separated post-median ones. Metathorax small, concealed to a great extent by the abdomen, which extends over it almost to the meso-metathoracic suture; viewed from above through the abdominal wall, it appears elongate, subtriangular, and rounded at the apex. Legs rather stout, especially the coxæ and femora. Anterior coxæ two-thirds as long as the femora and freely movable at base; the four posterior ones more or less connate and not so large. Posterior metatarsi enlarged and flattened, bearing six transverse rows of stout bristles (Fig. 9, *c*). One well-developed spur on posterior tibiæ. Legs everywhere covered with short hairs.

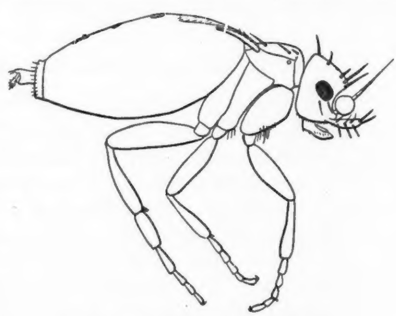

FIG. 7.—*Ecitomyia wheeleri*, n. sp. Female, side view.

Abdomen elongate, oval, acuminate, capable of being exserted at the tip, so that the last three segments may be retracted into the abdomen or pushed out for a distance equal to one-half that of the remainder of the abdomen. When retracted it is about twice as long as the head and thorax taken together. It is almost wholly membranous, only the very small dorsal plates being chitinized. First dorsal plate trapezoidal, as wide as long, and

narrowed basally; second, semicircular; third, subtriangular; fourth, twice as wide as long, rectangular. All except the first are almost rudimental. Just in front of the fourth plate there is a horseshoe-shaped piece of chitin, enclosing a pit from which projects a papilla from the interior of the abdomen (Fig. 9, *e*). Exterior sexual organs consisting of a stout longitudinal axis, obtusely pointed at tip, where it bears two macrochætæ (Fig. 9, *a*). The two lamellæ are attached laterally upon the sides of the central piece near the tip. Lamellæ about as long as the diameter of the central axis, elongate, gradually enlarged toward the tip, where they are rounded; covered with numerous stout bristles. All the apical segments of the abdomen bear several marginal macrochætæ.

FIG. 8.—*Ecitomyia wheeleri*, n. sp. Antenna.

Male (Fig. 10). Length .68 mm.; of wing the same. Body alutaceous. Thorax infuscated above. Abdomen piceous on basal three-fourths above, except on the anterior margins of the segments, where it is much paler. Antennæ, palpi, face, and legs pale testaceous. Anterior tibiæ black, except at extreme base. Hypopygium more or less black. Wings hyaline, veins pale. Head shaped much as in the female; eyes larger, not much smaller than in species of Phora; ocelli present, large, in a triangle on the vertex. Head seen from the side, about twice as high as long. Chætotaxy the same as that of the female, except that the most anterior pair of frontal bristles is shorter. The macrochætæ on the underside of the palpi are also somewhat weaker. Antennæ as in the female. Thorax arched in front, more than twice as long as the head. Scutellum well developed, bearing two strong discal macrochætæ. Dorsum with three marginal macrochætæ and a pair just before the scutellum. Legs longer and more slender than those of the female. Coxæ bristly at tip, hind trochanters each with a pair of very strong recurved spine-like macrochætæ. Wings large, as long as the body, with a stout longitudinal vein which meets the

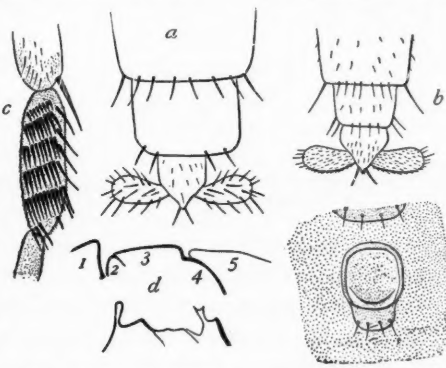

FIG. 9.—*Ecitomyia wheeleri*, n. sp. *a*, apex of abdomen, ♀; *b*, apex of abdomen, Phora sp. (?), ♀; *c*, hind metatarsus, ♀; *d*, diagrammatic median sagittal section of ♀; *1*, head; *2*, prothorax; *3*, mesothorax; *4*, metathorax; *5*, abdomen.

thickened costal margin near the middle of the wing, and three faint, oblique longitudinal veins. Costal vein bristly along its entire length. Halteres about as long as the hind metatarsus, distinctly three-jointed. Abdomen with six segments, the basal ones longest. It is chitinized above and membranous beneath. Hypopygium large, exserted, asymmetrical.

Described from numerous female and two male specimens collected at Austin, Texas, in the nests of *Eciton cæcum* Latr. and *Eciton schmitti* Emery, from October to February, the males only in February.

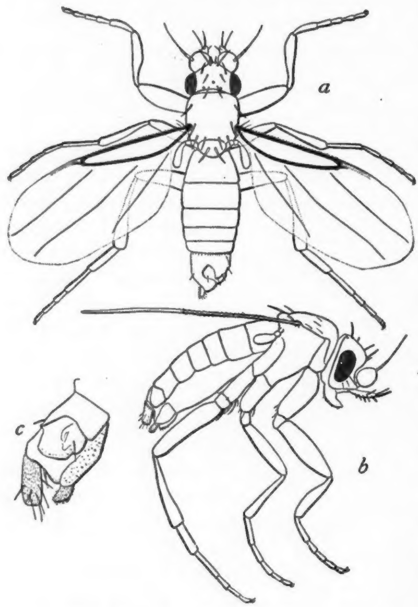

FIG. 10.—*Ecitomyia wheeleri*, n. sp., ♂. *a*, dorsal view; *b*, side view; *c*, hypopygium.

The head of Ecitomyia is much as in Commoptera, but is sharply angled at the posterio-lateral corners and longer on the vertex. The palpi are flattened and appear much thicker when seen from above. The eyes are considerably smaller than in Commoptera. The thorax is much wider than long and has no scutellum, while the metathorax is wholly concealed in the basal part of the abdomen. The appendages upon the dorsum of the thorax in the female of this species do not seem to be homologous with the similarly placed ones in Termitoxenia. They approach more closely to wings, while those in Termitoxenia are, in structure at least, like the halteres of Commoptera. That these appendages are wings is proved by their insertion evidently anterior to the meso-metapleural suture, and still more positively by their structure, as the homology of the thoracic segments is somewhat obscure. They are strap-shaped, and not round in cross-section; the dorsal side is

bristly while the ventral side is bare; they show no traces of any separate segments and articulations, whereas the halteres of Commoptera do. The presence of wings and absence of halteres are peculiar to this genus among all Diptera. Wings are often absent and rarely both wings and halteres, but in no other case are wings present without halteres. In *Eretmoptera browni* Kellogg ('00) the wings are much as in Ecitomyia, but the halteres, although somewhat reduced, are distinct. In Termitoxenia Wasmann considers the appendages of the thorax to be attached to the prothorax, which he believes to be greatly enlarged and to cover the dorsum of the entire thorax. This would certainly be an unusual development of the prothorax, and it seems much more reasonable to suppose that they are the halteres, or perhaps possibly reduced wings. It seems highly improbable that a dipteron prothorax should have suddenly become so large and have developed wing-like appendages. On the other hand, they are quite similar to the halteres of Commoptera, and Wasmann's appendices thoracicales could be easily derived from halteres. In Termitoxenia they seem to have taken on a new function, at least Wasmann so supposes from their peculiar form. He suggests that they may be of use as a means of attaching the animal to the body of the termite in order to be carried about.

The abdomen has somewhat larger dorsal plates than Commoptera, but they are nevertheless very much reduced, being scarcely visible from the side. The pit and papilla upon the anterior part of the fourth dorsal plate are shown in sections to be connected with a remarkable gland in the abdomen. The dorsal plate of the segment is continued forward to form a strongly chitinized ring which passes over into the plate posteriorly. Inside of this ring the integument is very thin and delicate, and is folded in to form a pit, surrounded on all sides by firm chitin. The bottom of the depression is swollen out in the middle to form a papilla, which is evidently to some extent eversible, as it shows a different form in almost every specimen. It often appears distinctly bifurcate at the tip. The tip of the papilla is covered with fine hairs and usually shows some refractive granules, most probably urates of some sort.

Internally the gland has a peculiar and complex structure (Fig. 11). The secretion seems to be formed in two elongate oval bodies lying in the dorsal part of the abdomen, and it is apparently carried through some intermediate, somewhat reticulately arranged cells to the surface of the papilla, which is lined with several layers of cells of varied size and form. The gland may perhaps supply some pleasant secretion for the ants, like the tufts of hairs developed in myrmecophilous Coleoptera, although I have not been able to decide by observation. I can find no reference to similar glands in any other insect, and hope at some future time to study them in detail.[1]

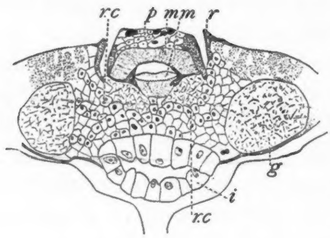

FIG. 11.—*Ecitomyia wheeleri*, n. sp. Cross-section of abdomen through gland. *g*, gland proper; *r.c*, reticulate cells; *r*, chitin ring; *p*, eversible papilla; *m*, membrane covering papilla and extending into abdomen; *i*, intestine.

We have found this species a great number of times, always associated with species of the ant genus Eciton. *Eciton cæcum* Latr., a totally blind species, which tunnels in the earth, seems to be its favorite host, although we found it upon one occasion in a nest of *E. schmitti* Emery, a species with very different habits, which lives in compact masses under stones, making its trips in search of food above ground.

The Ecitomyias are exceedingly quick and have the habit of darting rapidly about in zigzag paths in the way characteristic of many myrmecophiles. In the nests of *E. cæcum* they frequent those parts of the nest containing the greatest number of ants, being very often seen running along the galleries of the ants, into which they rapidly disappear when the nest is disturbed. Those occurring with *E. schmitti* seem to stay at a greater distance from the main body of the ants, but this species makes

[1] A very curious coincidence occurs in a new genus of wingless Proctotrupidæ which occurs in the nests of *Eciton cæcum*. *It also possesses a sharply defined roughening of the integument at exactly the same place that the gland of Ecitomyia has its opening!* I am sure, however, that there is no gland in connection with it. Can it be possible that this has any connection with some way these blind ants may have of recognizing their habitual nestmates?

large clusters and it might be dangerous for a myrmecophile to venture into these. It apparently prefers to move about in the vacant galleries of the nest.[1]

Some females which were placed in an artificial nest containing a number of *E. cæcum* workers soon made themselves at home and appeared much more at ease than the ants, which appear to be quite stupid and slow in adapting themselves to new conditions. Some of the flies preferred to rest upon the glass walls of the nest away from the ants. Others darted among the ants in the largest groups, while the ants regarded them without the slightest animosity. Any other fly or small insect introduced into the nest was viciously attacked by the ants and soon killed to serve as food for a large group of ants which had taken part in its destruction. Even dead legs and wings were picked up and carried about. Some Ecitomyias, however, which had presumably died a natural death, were not molested by the ants, and remained for a long time undisturbed. One of the Ecitomyias was apparently feeding upon some deposit left by the ants as they moved about, and it also approached some of the less excited ones after the manner of Myrmecophila, but I could not see that it obtained anything from the bodies of the ants.

Throughout the winter we had seen the females in almost every large nest which we examined, but although probably half a hundred nests were seen during that time, not until February did we positively find any males. In a large flourishing nest of *E. cæcum* which extended under stones for a distance of nearly twenty feet, we found numerous female and two male specimens. Although the male has ample wings, it did not attempt to fly, but hopped about in a similar but much less agile manner than the female, which is often exceedingly quick and hard to catch. The male does not hold the wings flat

[1] We have not been able to observe how they manage to follow the ants about as they make their regular changes of nest, for this ant does not remain in the same nest for any length of time, except probably during the breeding season. Other myrmecophiles of this species (*e.g.*, Staphylinidæ) march along in procession with their hosts as they make their curious journeys. As *E. cæcum* moves only by tunneling underground, they would experience no difficulty in keeping company with the ants.

upon the back, but keeps them in a slanting position, so that it resembles an exceedingly small aphid or psocid.

TERMITOXENIA WASMANN.

Thorax with one pair of dorsal appendages, apparently the halteres. Proboscis two-jointed, much produced, styliform or rostriform. Labrum with a styliform appendage anteriorly. Eyes small, ocelli very small. Halteres styliform or hooked at tip. Abdomen much swollen, curved downwards, anus directed forward.

This most remarkable genus is represented by four termitophilous species from Africa and India (Wasmann, '00a). Only females are known, although Wasmann considers some of his specimens as hermaphrodites, as they apparently possessed both ovaries and testes. He says, in speaking of *T. mirabilis:* "Jetzt sehe ich an Schnittserien der letzteren, dass dieselben Hermaphroditen sind mit noch kleinen ovarien und gut entwickelten Hoden." On such evidence we must not, however, suppose that winged males do not occur. Other cases of hermaphroditism among insects have been noted, but in no case is it established to be anything more than a pathological condition of certain individuals.

STETHOPATHUS WANDOLLECK.

Both wings and halteres absent, ocelli present, epistoma not large and prominent. Thorax rounded. Abdomen elliptical, first four dorsal segments strongly chitinized and well developed, covering the greater part of the dorsum of the abdomen. Abdomen not greatly retractile at apex, ovipositor short.

Only one species of this genus has been described, *S. ocellatus* Wand. from the East Indies. The specimens were found upon carrion and in the flowers of the giant Arum (Amorphophallus).

It was previously described by Dahl as the female of his *Puliciphora lucifera,* but because of his poor description and misunderstanding of its systematic position, Wandolleck redescribed it under a new name which it is probably best to adopt.

Chonocephalus Wandolleck.

Wings and halteres wanting, ocelli wanting, eyes small and sunk deeply into the head. Front almost horizontal. Thorax in profile triangular. Abdomen elliptical, with six strongly chitinized dorsal plates which extend far down upon the sides. Sixth ventral plate also present, almost meeting the sixth dorsal. Ovipositor long.

This genus is represented only by *C. dorsalis* Wand., from the Bismarck Archipelago. The imagines were found upon carrion.

In conclusion, I wish to express my greatest thanks and gratitude to Dr. Wm. M. Wheeler for the many kind suggestions and great help which he has given me throughout my work. I take great pleasure in naming one of the species in his honor as a slight token of my appreciation.

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'00b WASMANN, E. Neue Dorylinengäste aus dem neotropischen und dem äthiopischen Faunengebiet. *Zool. Jahrb.*, Abth. f. Syst. Bd. xiv, Heft 3 (1900), pp. 1–75, Taf. I, II.

UNIVERSITY OF TEXAS, AUSTIN,
March 1, 1901.

POSTSCRIPT.

After this article had gone to press, the author was so fortunate as to obtain two other new species of Stethopathinæ, even more remarkable than the ones described above. While collecting ants in the vicinity of Austin with Mr. A. L. Melander one afternoon during March, we found in a nest of *Eciton opacithorax* Emery a small insect which by its actions was at once recognized as a member of the Stethopathinæ. On carefully sifting the earth of the nest a second specimen was obtained. On comparing them we were exceedingly surprised to discover that not only were they different from any described Stethopathinæ, but were also quite unlike each other. They are both females which I intend to describe in the near future as representatives of two new genera. From this it would seem that there must be a whole series of these peculiar Diptera living as true myrmecophiles in the nests of various ants.

UNIVERSITY OF TEXAS, AUSTIN,
April 10, 1901.

THE METATHORACIC PTERYGODA OF THE HEXAPODA AND THEIR RELATION TO THE WINGS.

L. B. WALTON.

On the anterior margin of the prothorax and mesothorax of the Lepidoptera are two small sclerites known as the patagium and tegula, respectively; while in certain other orders of Hexapoda (Hymenoptera, Neuroptera, and Trichoptera) a small piece has been found at the base of the mesothoracic wing which has been considered equivalent to the tegula. Further than a few suggestions based on limited observations, no attempt has been made either to ascertain the value of these pieces or to demonstrate the existence of similar homodynamous or homologous structures in the hexapods.

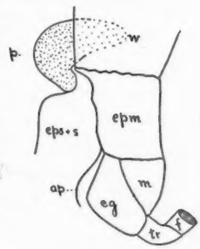

FIG. 1.— *Cossus ligniperda.* Left lateral portion of mesothorax. × 8. *p*, pterygodum (stippled); *w*, wing; *eps*, episternum; *epm*, epimeron; *cg*, coxa genuina; *m*, meron; *s*, sternum; *ap*, antecoxal piece; *tr*, trochanter; *f*, femur. Cut portion of femur represented by parallel lines. Dotted line shows pterygodum extending behind the anterior wing. All figures are placed in the same relative position, so that the upper margin represents the dorsal part of the thorax, while the margin at the left is the anterior portion of the thorax.

The purpose of the present paper is to call attention briefly to the general presence of a sclerite on the hexapod metathorax which seems homodynamous with the so-called tegula, to make some suggestions concerning terminology, and especially to point out that the present view concerning the metamerism of the antennate arthropods appears worthy of reconsideration.

The relation of the tegula, or pterygodum as I prefer to term it, to the pieces of the mesothorax, which is in many respects the most generalized of the three thoracic segments in the insects, is shown in Fig. 1. Bearing in mind now that the mesothorax and metathorax are equivalent,

the various components of each being reduplicated in the other segments, subject, however, to the factors governing the specialization of the different groups of insects, the existence of a corresponding piece in the metathorax would *a priori* be inferred. The presence of such a piece[1] is represented in the accompanying diagram (Fig. 2), while a homologous part can generally be demonstrated throughout the other orders (Figs. 3, 4). Furthermore, it is to be noted that in the typical form this is joined to the dorsal margin of the episternum, while the wing is articulated with the dorsal margin of the epimeron and not, as hitherto accepted, with the episternum.[2]

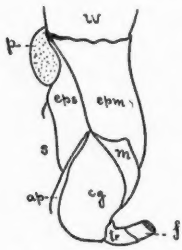

Fig. 2. — *Cossus ligniperda*. Left lateral portion of metathorax. × 8. References as in Fig. 1.

In connection with the facts noted above, certain evidence is available, based on embryology as well as comparative anatomy, which adds weight to the inference that these two pieces are rudimentary[3] wings and that the *thorax of the Hexapoda is composed of six somites which in the typical form bear the fundaments of six pairs of wings.*

The development of the mesothoracic pterygodum[4] (=tegula, parapteron, etc.) is of extreme interest in this connection and furnishes interesting evidence toward establishing the hypothesis I have put forward regarding its relation to the wing. This, however, is only one of a large number of facts which corroborate such a view and which appear explainable on no

[1] From comparisons made throughout the Hexapoda it is evident that this does not correspond to the more or less chitinized part of the epimeron at the base of the wing in most Lepidoptera.

[2] The anterior margin of the wing is generally specialized at the base, so that it partially extends over the dorsal portion of the episternum, while an articulative process of the pterygodum may be received into a corresponding notch of wing. (See Fig. 3.) This condition, however, is secondary.

[3] There appears to be no evidence for regarding these as vestigial, since it is improbable that forms with six pairs of wings ever existed. The term "rudimentary," as generally used, does not seem inappropriate, although the word "fundament" is more concise.

[4] Owing to its greater size, this can be more conveniently studied than the corresponding piece on the metathorax.

other basis. To one of these I have already called attention (Walton, **1900**), notably the formation of the coxa in Chilopoda and Hexapoda from two fused pieces to which I have applied the name "coxa genuina" and "meron."

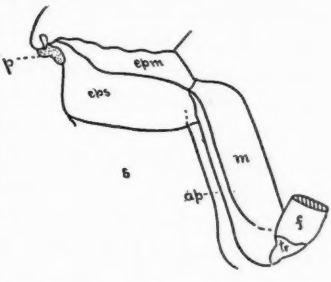

Fig. 3. — *Hydrophilus triangularis.* Left lateral portion of metathorax. × 8. Coxa genuina between ante-coxal piece and meron. Other references as in Fig. 1. Wing above epimeron, unlettered.

I have adopted the name "pterygodum"[1] for the present in preference to others which have been suggested for the mesothoracic piece (tegula, parapteron, squamula, etc.), since it has priority over terms otherwise acceptable, and according to our present knowledge better indicates the function of the part. The term "parapteron," which Comstock and Needham (**'98**), following Newport (**'39**), have used in reference to the mesothoracic pterygodum, appears inappropriate, for the reason that Audouin (**'24**) first used it to indicate a supposed sclerite on the anterior margin of the mesothoracic episterna in *Dytiscus circumflexus*, the part in question being merely an articulative process. Several years later, in a note to a translation of a paper by MacLeay (**'32**), Audouin stated his belief that the piece in the Hymenoptera termed squamula by MacLeay was homologous to the parapteron which he himself had described. This supposition was not only incorrect but was subsequent to the terminology adopted by Latreille.

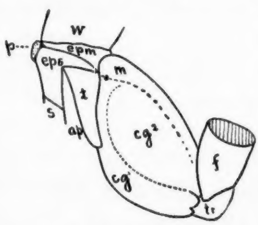

Fig. 4. — *Periplaneta orientalis.* Left lateral portion of metathorax. × 10. cg^1, anterior portion of coxa genuina; cg^2, posterior portion of coxa genuina, formed by the coxal groove for reception of femur; *t*, trochantin. Other references as in Fig. 1.

The value of the patagium on the prothorax has been more or less discussed, but until we know more concerning its development it is impossible fully to decide whether it is equivalent

[1] ⟨gr. πτερυγώδης ⟨πτερυγοειδής = πτέρυγος [wing] + εἶδος [form].

to the wing, as suggested by Cholodkowsky ('86), or to the pterygodum (tegula), the view adopted by Haase ('86) and now so generally accepted. It should be observed, nevertheless, that the reasons given by Haase for reaching such a conclusion are far from adequate, since the only evidence to which he called attention, otherwise than a superficial resemblance, was that (1) chitinous folds of a similar nature but of secondary origin are present on the prothorax of certain Hymenoptera and Diptera, while (2) the patagia do not exist during the larval stage of the Lepidoptera, but commence their development in the first few days of the chrysalid stage. Unfortunately, however, Haase failed to demonstrate any homologous structures in the Hymenoptera or Diptera, and had he attempted to do so it is evident, from the preceding, that proof of their secondary nature would have been difficult to establish. Moreover, the Anlage of a structure must exist *in potentio*, and the time during the post-embryonic stages at which it commences that which is known as development can alone be of no particular value in determining its palingenetic or cenogenetic character. The question as to whether the patagium represents a prothoracic pterygodum or a wing, must await a large amount of comparative work based on embryology, with the possibility of paleontological[1] evidence affording some help in the solution of the problem. The ratio of development between wing and pterygodum on the other thoracic segments allows the inference, however, that pterygoda may

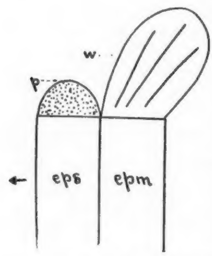

FIG. 5. — Typical form showing relations of pterygodum, wing, episternum, and epimeron in the thoracic segment of the Hexapoda. References as in Fig. 1.

[1] The prothoracic appendages of certain fossil insects (*Homoioptera woodwardi*, *Stenodicta lobata*, *Lithomantis goldenbergi*, *carbonaria*, etc.) so excellently figured by Brongiart (*Recherches pour servir à l'histoire des insectes fossiles*, Paris, 1894) cannot be homologized with the expanded margin of the prothorax in existing Mantidæ, as Woodward (*Quart. Journ. Geol. Soc.*, vol. xxxii, p. 60, London) suggested. Brongiart has already pointed this out. (Note sur quelque insectes fossiles du terrain houiller qui presentent au prothorax des appendices aliformes, *Bull. Soc. Philom.*, tome ii, 1890.)

exist in front of the patagia which then have the value of wings.

Another interesting question in this connection is the homology of the elytra of Coleoptera, for again further investigation must be awaited before a logical conclusion can be reached. The tracheation of the elytra, to which attention has been called by Comstock and Needham (**'98**), is not conclusive evidence that they are specialized wings, for in connection with the view I have here advocated this would be expected if they were homologous with the mesothoracic pterygoda of the Lepidoptera, and the suppressed wing was represented by the alulet so noticeable under the Elytra in Hydrophilus, etc.

From the preceding facts, to which I have called attention, it appears necessary to consider that the typical thoracic segment (Fig. 5) possesses the components of both pterygodum and wing, the former joined to the dorsal margin of the episternum, the latter articulated with the dorsal margin of the epimeron, while furthermore the morphological position of the pterygodum in respect to the wing indicates that it may have an important bearing in elucidating the metamerism of the antennate arthropods.

ANATOMICAL LABORATORY, BROWN UNIVERSITY.

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PHAGOCYTOSIS IN THE POSTEMBRYONIC DEVELOPMENT OF THE DIPTERA.

VERNON L. KELLOGG.

In the most recent considerable[1] paper on the postembryonic development of an insect of complete metamorphosis, the author lays much stress on the small part which phagocytes play in the breaking down of the larval tissues during the metamorphosis of the insect studied — the little brown ant, *Lasius flavus*. In this respect the author sees in the metamorphosis of Lasius (belonging to the Hymenoptera) a sharp contrast to the metamorphosis of the Diptera, in the best-known example of which, the much-studied Calliphora, phagocytosis plays an all-important part. Korotneff[2] found in the case of the degeneration of the larval muscles of Tinea (Lepidoptera) that there was no phagocytosis. Rengel,[3] in studying the changes in the alimentary epithelium of Tenebrio and other Coleoptera, found also no phagocytosis, and Needham,[4] in a careful study of the flag weevil (*Mononychus vulpeculus*), similarly found a complete lack of phagocytosis in the histolysis of the larval tissues of this insect. Karawaiew strongly agrees with Korotneff and Rengel in believing that phagocytosis is a phenomenon of postembryonic development associated with the length of time occupied by the metamorphosis. With the blowfly the metamorphosis occupies but a few days; with Tinea, a little more than two weeks; with Tenebrio, several weeks, according to the temperature; and with the ants still

[1] Karawaiew, W. Die nachembryonale Entwicklung von Lasius flavus, *Zeitschr. f. wiss. Zool.*, Bd. lxiv (1898), pp. 385-478, Pls. IX-XII, and 15 figs. in text.

[2] Korotneff, A. Histolyse und Histogenese des Muskelgewebes bei der Metamorphose der Insekten, *Biol. Centralbl.*, Bd. xii (1892), pp. 261-265.

[3] Rengel, C. Ueber die Veränderungen des Darmepithels bei Tenebrio molitor während der Metamorphose, *Zeitschr. f. wiss. Zool.*, Bd. lxii (1896).

[4] Needham, J. G. The Metamorphosis of the Flag Weevil (Mononychus vulpeculus), *Biol. Bull.*, vol. i (1900), pp. 179-191.

longer; in the case of *Lasius flavus*, for example, from the first warm spring days until the beginning of June or even longer. In the case of the insects, like the flies, with a short time devoted to metamorphosis, there must be space made for the new organs as quickly as possible; that is, the old larval organs must get out of the way as soon as may be. The natural process, a gradual degeneration, is a process of long duration, and on that account not sufficient in the case of the flies. Hence, says Karawaiew, there has arisen the barbaric devouring of the tissues by the leucocytes.

It has seemed to me unfortunate that in the study of the postembryonal development of the Diptera so much attention should have been given to the highly specialized Muscidæ and so little to more generalized members of the order. The metamorphosis of Coretha, Culex, and Chironomus has been studied somewhat, but without any approach to that exhaustiveness which characterizes the studies of Weismann, Van Rees, Kowalevsky, *et al.*, on Calliphora. In the hope of finding some new light upon these extraordinary phenomena of histolysis and histogenesis which are a part of insect metamorphosis I have undertaken the study of the postembryonic development of two flies belonging to the more generalized Diptera, the Nematocera. One of these flies is *Blepharocera capitata*, a member of the strange, small family, Blepharoceridæ, with strangely and strongly modified immature stages, and the other is *Holorusia rubiginosa*, a giant crane fly (Tipulidæ), with simple immature stages. While both of these forms are nematocerous Diptera, and to this extent allied, there is an exceptionally wide divergence between them in point of structure of the larval stages, and this difference has, to my mind, an all-important influence in determining the obvious and suggestive differences in the character of the development, which, we shall see, obtains. This present reference to the metamorphosis of these two dipterous forms has to do solely with the peculiarly interesting and suggestive conditions of the histolytic processes in the metamorphosis.

The larva of *Holorusia rubiginosa*[1] is cylindrical, worm-like, tapering slightly towards both ends, without feet or other special organs of locomotion. It attains a length of three inches (outstretched full-grown specimens). The head is a retractile, strongly chitinized capsule, with biting mouth-parts. The internal anatomy is simple. The musculation consists, except in the head, of simple segmental, longitudinal, integumental muscles and of annulate integumental muscles. Locomotion is a simple squirming or wriggling, caused by longitudinal contractions. The alimentary canal is a straight tube divisible into the usual parts. The ventriculus has four diverticula or cæca, and the large intestine has a single forward projecting diverticulum. There are four Malpighian tubules. There is a single pair of large salivary glands, each gland bent double. The respiratory system consists of a single pair of large spiracles situated on the posterior aspect of the last abdominal segment, and of a pair of main longitudinal tracheal trunks with their branches. The larval life lasts several weeks.

The pupa is found in the same place inhabited by the larva, and is of simple character. It is from one and one-fourth to one and three-fourths inches long. There is a pair of slender, short respiratory tubes on the prothorax. The pupal stage lasts twelve days.

In the course of the postembryonic development of Holorusia I have found no occurrence of phagocytosis. The breaking down of the muscles and salivary glands and fat body of the larva (tissues in which phagocytosis most certainly occurs if at all and in which it is most readily determinable) is accomplished apparently entirely by simple "*selbständige Degeneration*" (Karawaiew). The breaking down of the muscles does not begin until after the pupal life is well started. In fact there is no very great breaking down essential. The musculation of the adult differs from that of the larva more in the addition of the wing and leg muscles of the thorax

[1] This is the first published reference to the immature stages of this giant tipulid. The larvæ were found abundantly on the banks of a small stream near this university (Stanford), lying in mud and slime composed of decaying leaves.

and the muscles of the head than in any complete substitution of an imaginal musculation for a previous wholly different complex larval musculation. In pupæ one-third through their existence (four days old) a great deal of the larval musculation still persists side by side with the developing new muscles of the thorax. The nuclei of the degenerating larval muscles show the "old-age" characters of degenerating nuclei; the contractile substance first loses its striate appearance, then becomes loosely fibrous, then spongy, and finally breaks up.

The degeneration of the large salivary glands is easily followed. In the larvæ the nuclei of the large epithelial cells

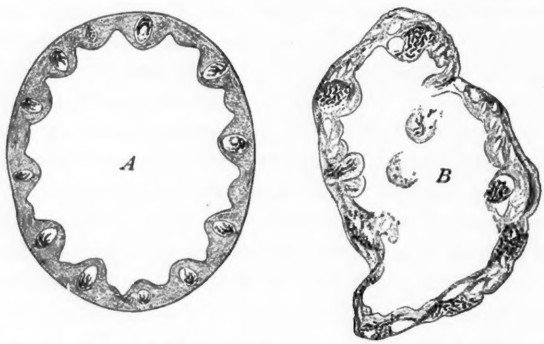

FIG. 1. — Salivary gland of *Holorusia rubiginosa*: *A* cross-section of gland of larva; *B*, cross-section of gland in pupa forty-eight hours old, degeneration being well advanced.

are regularly circular or elliptical (in optical plane) and sharply delimited by a nuclear membrane. The chromatin is rather massed together and stains strongly. The cytoplasm of the cells is evenly granular and the cell outlines well defined (Fig. 1, *A*). In a pupa not more than twenty-four hours old a marked degeneration of the cells has occurred. The cytoplasm is distinctly vacuolated, and in a pupa a day or two older the cytoplasm is spongy, the cells have lost their shape, the nuclei have lost their membranes and are showing other degenerative characters (Fig. 1, *B*). No phagocytes appear. The degeneration or histolysis of the larval tissues of Holorusia is accomplished thus without the interference of phagocytes. The pupal condition is characterized by no such extensive breaking down

of larval organs as is apparent in the pupæ of Calliphora, where the pupal body cavity is filled with "pseudo-yolk," a confused fluid mass of degenerating tissue.

The larvæ of *Blepharocera capitata*[1] are of extraordinary external appearance, and in their habits and structure are widely removed from other dipterous larvæ. They live under water in brooks, clinging by six elaborately developed ventral suckers to the smooth rock bed or to smooth stones in parts of the stream where the water runs swiftly and is shallow. The segments of the body are greatly modified, the three thoracic segments and the head being fused to form a single large anterior body region. For the control of the suckers and for the peculiar lateral swinging movement of the body in locomotion an elaborate musculation is developed, which is very different from the musculation of the adult fly. The pupæ are also extraordinary in character and live, like the larvæ, attached to the rocks in swift, shallow parts of the stream. The duration of the pupal stage is fifteen days. The histolysis of the larval tissues begins three or four days before the true pupal condition is reached. The larvæ cease feeding, become quiet, and thus remain three or four days before pupation. The total duration, therefore, of the time devoted especially to the change from larva to imago is about eighteen days, as compared with twelve in the case of Holorusia.

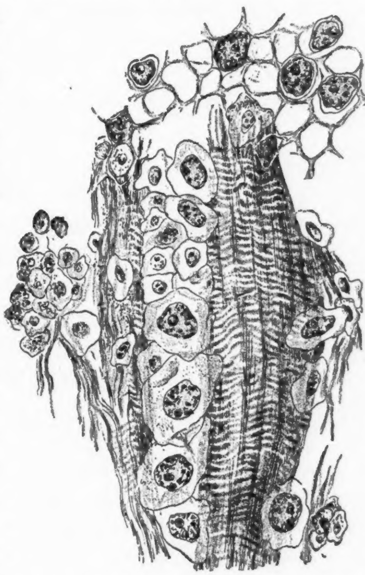

FIG. 2. — Larval muscle of *Blepharocera capitata*, attached by phagocytes, in a pupa a few days old.

[1] For an account of the structural character of the larvæ, see Kellogg, Notes on the Life-History and Structure of Blepharocera capitata Loew, *Ent. News*, vol. xi (1900), pp. 305–318.

There is a great breaking down of the larval organs of Blepharocera. With such a specialized larval life there is a great difference between the larval organs and the imaginal organs. The musculature, the alimentary canal, and the respiratory system are largely broken down and reformed. And in all of this histolysis phagocytes are abundant and conspicuous. When pupæ not more than three or four days old are dissected, the body cavity is found to be filled with "pseudo-yolk," that is, with a lymph-like liquid containing floating bits of degenerating tissue and hosts of phagocytes. A bit of larval muscle (Fig. 2) in a pupa a few days old shows very well the character and effects of the phagocytosis.

Thus in the fly Blepharocera, with its eighteen days of prepupal and pupal condition, phagocytosis is conspicuously present; in the fly Holorusia, with its twelve days of pupal condition, histolysis is unaccompanied by phagocytosis. The fly in which the histolytic phenomena occupy the longer time is the one in which the histolysis is accompanied by phagocytosis. This is a condition not at all in consonance with Karawaiew's conclusions, as quoted at the beginning of this paper.

What is the reason for the presence of phagocytes in the histolysis of Blepharocera and their absence in Holorusia? To my mind, the extent of the metamorphic changes, the degree to which histolysis occurs, probably offers the explanation. In Blepharocera, with its highly specialized larval form, its peculiar and specially developed organs, the change to imago is radical; the histolysis of larval tissues is extensive. In Holorusia, with its generalized larval form, its less modified organs, the change to imago is accomplished with much less breaking down of larval organs and reformation of imaginal ones; the histolysis is less radical and considerable. The phagocytes are the agents or the assisting agents in the more extended and radical histolysis.

My observations so far do not enable me to offer any evidence regarding the moot point touching the causal agency of the phagocytes in histolysis. Whether the phagocytes initiate histolysis, or merely render effective aid after the degeneration has been initiated independently, is a question of importance.

ON THE SIGNIFICANCE OF THE SPIRAL SWIMMING OF ORGANISMS.[1]

H. S. JENNINGS.

It is a well-known fact that many of the lower organisms swim in a spiral path, but the real significance of this fact has never been pointed out, I believe, until recently. Swarm-spores, flagellate and ciliate infusoria, rotifers, and many other lower organisms as they pass through the water revolve on their long axes, and thus follow a course that takes the form (as a rule) of a spiral. Extended discussions of this fact are to be found in many works, as in Bütschli's "Protozoen" in Bronn's *Klassen und Ordnungen des Thierreichs*, and in many special papers. These discussions usually confine themselves to a description of the facts, — so far as these were made out, — and to a discussion of the mechanical factors involved in producing the spiral movement, without any attempt to show the biological significance of the phenomenon. To understand the significance of this method of swimming was indeed perhaps impossible until the relation between it and the method of reaction to a stimulus in these organisms was known, and especially until it was recognized that *the body of the organism bears a constant relation to the axis of the spiral*, — that is, that the same side of the organism is always directed toward the outside of the spiral (as in Fig. 1). These relations were first pointed out by the present writer in Nos. II and V of his "Studies on Reactions to Stimuli in Unicellular Organisms,"[2] where they were shown to hold for a considerable number of Flagellata and Ciliata.

[1] The substance of this paper was presented at the meeting of the Western Naturalists in Chicago, Dec. 27, 1900.

[2] II, The Mechanism of the Motor Reactions of Paramecium, *Am. Journ. of Phys.*, vol. ii (1899), p. 323; V, On the Movements and Motor Reflexes of the Flagellata and Ciliata, *Am. Journ. of Phys.*, vol. iii (1900).

The exact purpose that is served by this method of swimming is a point deserving of further emphasis and fuller discussion. The Flagellata and Ciliata are as a rule unsymmetrical in form. One of these organisms, as, for example, Loxodes (Fig. 2), or Paramecium (Fig. 3), when it leaves the bottom and starts to swim freely through the water, cannot go in a straight line, but owing to its lack of symmetry continually swerves toward one side, so that it tends to describe a circle. If no method is taken of compensating this deflection, the circles described are frequently very small, and of course the animal makes no progress by swimming in this way. Paramecium and Loxodes thus tend to circle toward the aboral side, Chilomonas (Fig. 4) toward its "lower lip," all the Hypotricha to the right, etc.

FIG. 1. — Diagram of spiral course of Loxodes when swimming freely through the water. If *a* and *c* are conceived as being in the plane of the paper, then *b* is above and *d* below this plane.

To obviate this difficulty, revolution on the long axis is combined with the forward movement of the organisms. By this means the continual swerving toward one side is compensated, since this side is continually turned in a new direction. Thus, if Loxodes is swimming (freely through the water) away from the observer, and the aboral side is at first to the observer's left (Fig. 1, *a*), the organism at first swerves to the left; but as it revolves the aboral side soon comes to be the upper side, and the animal now swerves up (*b*). By continued revolution the aboral side is brought to the right (*c*), so that the animal swerves to the right. Next, of course, it swerves down and the process is continued, the animal swerving successively to the left, up, right, down, etc. These movements, of course, compensate each other, so that only the forward component of the motion is

effective; the animal thus moves forward as if on a straight line, — the actual path being a spiral with a straight axis. The principle is the same as that by which a rifle bullet is given a straight course by making it revolve in the axis of flight.

In the Hypotricha a similar course is followed, save that the swerving is to the right; in Chilomonas (Fig. 4) it is toward the lower lip (*a*). Such a spiral path is known to be followed by most of the free-swimming Protista, — by swarm-spores, flagellates, and ciliates in general; by Volvox, Eudorina, Pandorina, Platydorina, etc. In some of these organisms the course followed becomes almost an actual straight line, owing to the fact that the body is symmetrical, so that there is no pronounced swerving toward one side. Such is the case, for example, in Volvox. Here the revolution on the long axis probably serves merely to compensate for any accidental deviations that may occur through injury, unequal development, and the like. Such cases are comparatively rare, however, most of these organisms being markedly unsymmetrical.

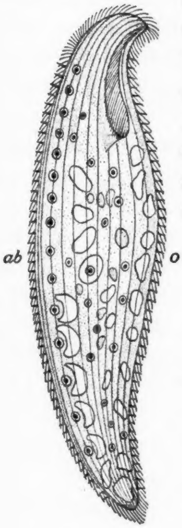

Fig. 2.

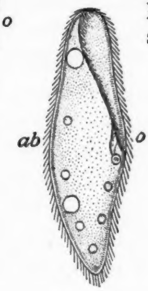

Fig. 3.

Fig. 4.

Fig. 2. — *Loxodes rostrum*, after Bütschli, showing the unsymmetrical form. *ab*, aboral side; *o*, oral side.

Fig. 3. — *Paramecium caudatum*. *ab*, aboral side; *o*, oral side.

Fig. 4. — *Chilomonas paramecium*, after Bütschli. *a*, "lower lip."

The mechanical cause of the revolution on the axis of progression has often been discussed. In the Ciliata there seem to be three possible factors: (1) an oblique stroke of the cilia; (2) the oblique position of the peristome; (3) the unsymmetrical form of the body, which is often of such a shape as to favor rotation in a given direction. That the first factor is the primary one is indicated by the fact that the direction of revolution may be reversed in many of these organisms, even when

the form of the body is such as to oppose this reversal. The unsymmetrical form seems rather an adaptation to this method of swimming, — a consequence of it. Many of these organisms are so shaped that the body forms part of a spiral; this is to a certain degree the case, for example, in Paramecium (Fig. 3). In some others this is much more marked. Phacus, for example, is frequently strongly spiral. Some of the bacteria swim in this same manner, and among these, Spirillum forms, as is well known, a sort of animated corkscrew. The prevailing asymmetry in the unicellular organisms is closely correlated with this method of swimming.

When creeping along the bottom (as Loxodes usually does), or when in contact with any solid object, these same organisms exhibit no such rotation. When moving along a surface there are, of course, only two chances to err from the straight line, either to the right or to the left. When swimming freely through the water, on the other hand, the chances of deviation are indefinitely numerous, since the organism may swerve to the right or left, or up or down, or in any intermediate direction. Moreover, when in contact with a surface, this usually presents numerous stimuli, which serve as directives of motion, while in the free water such stimuli are lacking. Hence the necessity of some special device for keeping the straight course in the latter case. The movements and reactions of organisms differ greatly when they are moving along a surface from those exhibited when passing freely through the water. (Pütter[1] has recently published a valuable paper on this subject.) Both flagellates (*e.g.*, Peranema) and ciliates move without rotation when in contact with a surface. Yet even then they usually cannot travel in a straight line; Colpidium and Oxytricha, for example, follow a much curved course.

As the present writer has fully set forth in his "Studies on Reactions to Stimuli" (*loc. cit.*), this method of locomotion is closely related with the usual method of reaction to a stimulus. In addition to swerving toward a structurally defined side in

[1] Pütter, August. Studien über Thigmotaxis bei Protisten, *Archiv f. Anat. u. Phys.*, Physiol. Abth., Supplement Band (1900), pp. 243–302.

their locomotion, these unsymmetrical organisms respond to a stimulus by turning toward a structurally defined side.

It is important not to misunderstand the nature of this spiral motion. If one of these swimming organisms is viewed from above with the ordinary microscope, the path of the organism seems to swerve merely first to the right, then to the left. This is of course because the upward and downward part of the path is lost from view with the ordinary microscope which sees approximately in a single plane; with a stereoscopic binocular the real nature of the path is evident. If the constant relation of the body of the organism to the axis of the spiral is likewise overlooked, a peculiarly false conception of the movements of these organisms is obtained, which seems to be somewhat widespread. This is the conception that the organism swerves as it swims, first toward one side, then toward the other.

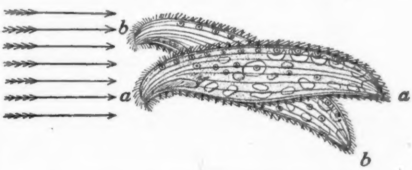

FIG. 5. — Diagram to illustrate supposed oscillation of an unsymmetrical organism when oriented by lines of force (represented by the arrows).

For example, Loxodes or Paramecium, according to this view, would swerve first toward the aboral side, then toward the oral side. This supposed movement has even been given a high theoretical significance, as being the natural result of the orientation of an unsymmetrical organism by lines of force, such as rays of light, or the path of diffusing ions. Thus, in Fig. 5, in the position *a–a*, in which the axis of the organism is parallel with the lines of force, more lines of force impinge on the convex side of the organism; hence the locomotor organs on that side act more (or less) strongly than those on the concave side. As a result of this differential action, the organism swings (supposedly) to the position *b–b* (that is, it swings toward the aboral or convex side). Now more lines of force impinge on the concave side; the locomotor organs act more (or less) strongly on this side, and the organism swings again (now toward the oral or concave side) into the position *a–a*. This continues, and, combined with the forward motion,

supposedly accounts for the sinuous path of these organisms. It should be clearly stated that the actual movements of these creatures lend no support to this account, but are, on the contrary, quite incompatible with it. The organisms swerve always toward the *same* side, not first to one side, then to the other.

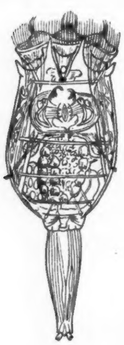

FIG. 6. — Dorsal view of a rotifer (*Brachionus pala*, after Weber) to show the similarity of the two sides.

But it is well known that it is not only unsymmetrical organisms that swim in a spiral, but that the same is true for many bilateral organisms also, — as, for example, the Rotifera. Since the two sides are alike in these animals (see Fig. 6), there is no reason for swerving to the right rather than to the left, and the spiral path calls for some further explanation. The significance of the spiral path in such cases is clearly seen when the movements of these animals are carefully studied. When creeping on the bottom or the surface film, there is no rotation. Here the only possibilities of deviation from the straight line are either to the right or to the left, and since the two sides are alike there is no reason for swerving in either direction. But the dorsal and ventral sides are not alike (see Fig. 7), and in swimming freely through the water the animal might err by turning toward the dorsal or toward the ventral side, or in any intermediate direction. As a matter of fact, careful observation shows that most rotifers do swerve toward the *dorsal side* as they swim freely through the water. This tendency seems traceable to the fact that the rotifers are primitively creepers on the bottom, and most of them still retain this habit. In order to rise from the bottom into the free water, the animal must necessarily move toward the dorsal side (as in Fig. 7). The cilia which bring about the free-

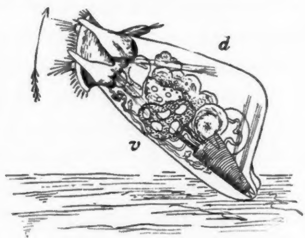

FIG. 7. — Rotifer (*Brachionus pala*, modified from Hudson and Gosse), side view, showing the turning toward the dorsal side when rising from the bottom. *d*, dorsal side; *v*, ventral side.

swimming movement seem to have this tendency, to strike so as to turn the animal toward the dorsal side, strongly ingrained. Many of these animals cannot rise from the bottom so long as the dorsal side is down. In such a case the dorsal side of the head repeatedly strikes the bottom until, by revolving on the long axis, the dorsal side is turned toward the free water; the animal then swerves off the bottom in that direction. Some

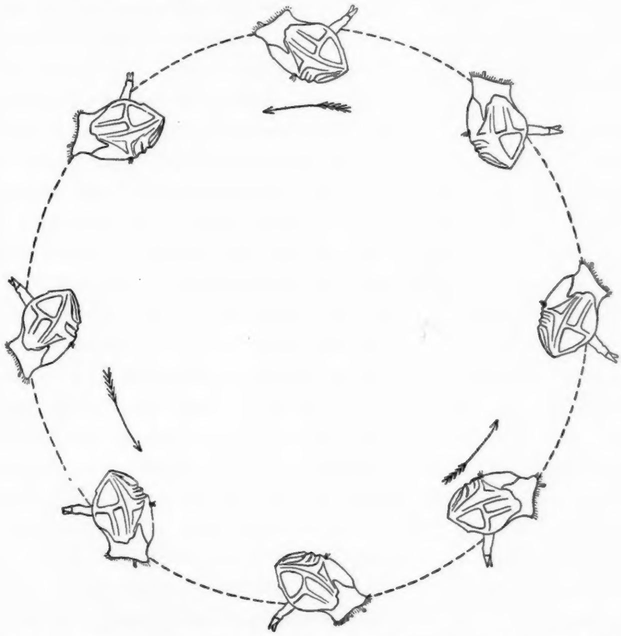

FIG. 8.— Diagram showing course followed by Plœsoma when swimming without revolving on the long axis. The animal continually swerves toward the dorsal side, hence follows a circular path.

of the rotifers, if they attempt to swim freely through the water without revolving on the long axis, turn backward somersaults, over and over, describing thus small circles. I have seen Plœsoma thus describe circles (Fig. 8) for considerable periods. But as soon as the animal begins at the same time to revolve on the long axis, without otherwise changing its movement, the effect is striking. The purposeless circular movement

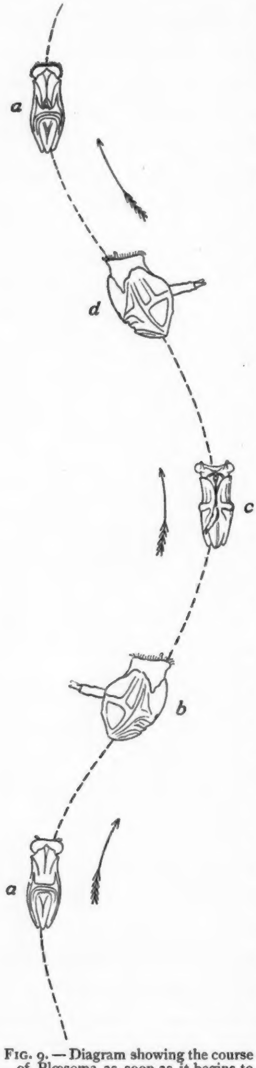

FIG. 9. — Diagram showing the course of Plœsoma as soon as it begins to revolve on the long axis (*a* and *c* are higher and lower, respectively, than *b* and *d*, which lie in the same plane). This spiral course, with the dorsal side to the outside of the spiral, is characteristic for many Rotifera.

(Fig. 8) becomes at once a well-ordered progression in a spiral path (Fig. 9). No one who has seen this sudden change from random circles to a path having all the essential qualities of a straight line can fail to appreciate the biological significance of the rotation on the long axis in compensating the tendency to swerve in a given direction.

This tendency to swerve toward the dorsal side seems present in the majority of the free-swimming Rotifera, and is compensated almost universally by the revolution on the long axis, causing the resulting path to be a spiral with the dorsal side directed toward the outside of the spiral (Fig. 9). All rotifers observed by the writer revolve to the right, and no reversal of the direction of revolution was ever seen.

In some of these primitively bilateral animals this spiral method of swimming has resulted in the production of an unsymmetrical form analogous to that of the infusoria. In the small aberrant family of Rattulidæ this adaptation to a spiral movement is most striking. *Rattulus tigris*, for example, has a twisted body, forming actually a segment of a spiral, and there is in addition a high spiral ridge on one side. This ridge begins behind the middle, near the mid-dorsal line, and passes forward, at the same time curving over to the right side. The animal swims in a spiral of which this ridge and its own twisted body form a part.

Asymmetry appears sporadically in many different groups of the Rotifera; possibly it may in every case be brought into relation with the spiral method of swimming.

The Rotifera are a group of organisms excessively varied in form and movements, furnishing a most excellent opportunity for studies on the interdependence of structure and function. Some species (*e.g.*, certain species of Diaschiza) have the body so curved ventrally that the tendency to turn toward the dorsal side is more than compensated, and the animal tends instead to curve continually toward the ventral side. This tendency is of course likewise corrected by the revolution on the axis of progression, the path taking here the form of a spiral with the ventral surface to the outside.

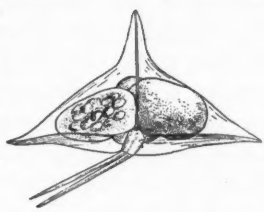

FIG. 10. — View of a swimming *Euchlanis triquetra* from behind (after Ehrenberg) to show the three keels.

Some few rotifers have become so modified that revolution on the long axis has become unnecessary for keeping a straight course. Thus *Euchlanis triquetra* (a view of which from the rear is shown in Fig. 10) has developed three great keels, one dorsal and two lateral, which tend to prevent swerving in any direction; so this animal frequently swims freely for long stretches without revolving, while the closely related *Euchlanis oropha* (having no keels) almost continually revolves as it passes through the water.

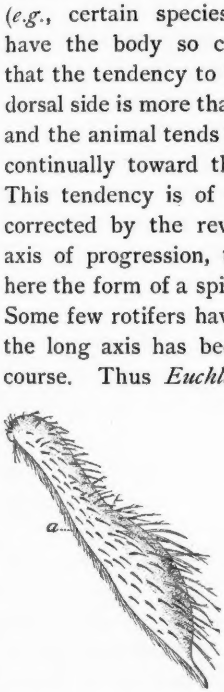

FIG. 11. — One of the Gastrotricha (*Chætonotus macrochætus*, after Zelinka), showing the position of the cilia (*a*) on the ventral side.

Revolution on the long axis, with the resulting spiral path, is common also in many other animals. In the Gastrotricha (*e.g.*, Chætonotus, Fig. 11) the locomotor organs (cilia) are confined to a strip on the ventral side, (*a*) which necessarily results in giving the organism a tendency to turn toward the dorsal side. The revolution on the long axis is therefore of great importance for producing an effective forward movement.

Revolution on the long axis is also to be observed in many rhabdocœls. It is indeed one of the commonest features in the locomotion of small fresh-water organisms, and doubtless occurs in salt-water forms in the same way.

On the whole, then, it is clear that revolution on the long axis, with the resulting spiral path, is of high biological significance. Only through this device are many organisms enabled to follow a course which is practically a straight one; without such revolution many creatures merely describe small circles, making no progress whatever. By means of this revolution on the long axis, any organism, no matter how misshapen and irregular, may follow a course which is, in effect, equivalent to a straight line. The simple device of revolving in the axis of progression is surprisingly effective, in that it compensates with absolute precision for any tendency or combination of tendencies to deviate from a straight course in any direction whatsoever.

ANN ARBOR, MICH., January 5, 1901.

SYNOPSES OF NORTH-AMERICAN INVERTEBRATES.

XIV. The Hydromedusæ — Part II.

CHAS. W. HARGITT.

The Campanulariæ (Calyptoblastea).

The Campanulariæ are distinctively colonial Hydromedusæ, many of them most exquisitely beautiful and graceful forms. In size they vary from very minute forms barely visible to the unaided eye, to forms like Halecium, measuring from twelve to twenty inches or more in height. The hydranths are provided with specialized receptacles, hydrothecæ, into which they are capable of more or less complete retraction. Gonophores are produced by budding, and are provided with specialized receptacles, gonangia, similar in morphological features to the hydrothecæ. The gonophores may be liberated as free medusæ, or may remain fixed as medusoids, the sexual products maturing within the gonangium and later escaping as free larvæ or planulæ. When free, the medusæ are known as Leptomedusæ, characterized generally by a low, flat bell, marginal sense organs usually of the vesiculate type, with the gonads usually borne along the underside of the radial canals.

A classification of the Campanularidæ is almost, if not quite, impossible without the presence of the gonosome, which in many genera is the most distinctive differentiating feature. In the following synopsis this feature will be in constant requisition, and where it is absent in specimens the student is admonished as to the doubtful character of purely morphological determinations.

SYNOPSIS OF FAMILIES.

CAMPANULARIDÆ. Hydrothecæ campanulate, terminal, borne on distinct pedicels ; gonophores fixed or free-swimming. Hydranths with large and somewhat trumpet-shaped hypostome.

LAFŒIDÆ. Hydrothecæ deep tubular, sessile or pedicellate ; hydranths with conical hypostome.

HALECIDÆ. Hydrothecæ usually reduced to shallow, disk-like receptacles (hydrophores). Hydranths with conical hypostome. Gonophores as imperfectly developed medusoids.

SERTULARIDÆ. Hydrothecæ borne in double rows, adnate to hydrocaulus. Gonophores sessile.

PLUMULARIDÆ. Hydrothecæ arranged in single row only on side of hydrocaulus.

CAMPANULARIDÆ.

Synopsis of the Genera.

CLYTIA. Stems simple or rarely branched. Hydrothecæ deeply bell-shaped, with toothed margins, borne on long pedicels. Gonangia producing free medusæ having four marginal tentacles.

OBELIA. Stems regularly branched, hydrothecæ bell-shaped, with entire margins. Gonangia borne on stems and branches and producing free medusæ having numerous marginal tentacles.

CAMPANULARIA. Stems simple or branched. Hydrothecæ campanulate, with margins entire or variously toothed. Gonangia, medusæ as mere sporosacs, within which the sexual products develop and escape as free planulæ.

GONOTHYRÆA. Stems branching ; hydrothecæ campanulate and with toothed margins. Gonangia producing well-developed medusoids, which, while often furnished with tentacles and capable of protruding beyond the orifice of the gonangium, never become free, thus exhibiting an interesting intermediate stage between the first two genera and Campanularia.

Clytia Lamx. (in part).

Generic characters : Stem usually simple, attached by creeping hydrorhiza. Hydrothecæ devoid of operculum. Gonangia produced from stem or hydrorhiza and borne on pedicels which are usually beautifully annulated. Gonosome. Medusæ deeply bell-shaped and with four marginal tentacles when first liberated. Otocysts eight, two in each interradius. Both these and the tentacles increase in number with the age of the medusa.

1, *C. bicophora* Ag. (Fig. 16).

Trophosome : Colony rarely attaining a height of more than an inch, composed of simple or sparingly branched stems. Hydrothecæ deeply bell-shaped and numerously and sharply toothed, borne on elongate pedicels which have terminal annulations.

Gonosome : Gonangia symmetrically annulated and usually arising from the hydrorhiza. Medusæ when first liberated of hemispherical shape and with four tentacles and eight otocysts.

Habitat : Usually on fucus, occasionally on shells or other hydroids.

Fig. 16. — *Clytia bicophora* Ag. (After Agassiz.)

2, *C. cylindrica* Ag.

(*Cont. Nat. Hist. U. S.*, vol. iv.)

Trophosome : Stems simple, hydrothecæ tubular, small, deep, with sharply pointed teeth. Pedicels short, with proximal and distal annulations.

Gonosome : Gonangia oblong, somewhat flattened, devoid of annulation, producing free medusæ.

Habitat : Similar to last species.

3, *C. grayi* Nutting.[1]

Trophosome : Stem simple or irregularly branched, strongly annulated except in middle branch. Hydrothecæ very large, cylindrical. Numerous marginal teeth, rounded and not deeply cut. Hydranth with about twenty tentacles.

Gonosome : Gonangia oblong, conspicuously and regularly annulated, attached to creeping rootstocks.

Habitat : Growing on living worm tubes, composed of sand. Dredged from depth of 31 fathoms. The largest Clytia yet found in American waters.

Obelia Peron and Leseur.

Generic characters : Colony often plant-like, of whitish color, attached by creeping hydrorhiza ; hydrothecæ campanulate and devoid of operculum. Gonangia borne on stems and branches, producing free medusæ characterized by numerous marginal tentacles, four radial canals, and eight otocysts symmetrically disposed on the inner margin of each interradial quadrant.

[1] Condensed from Professor Nutting's original description.

1, *O. commisuralis* McCr. (FIG. 17).

Trophosome: Colony long, slender, profusely branching, branches spreading in graceful curves on each side of the main stem, which may attain a height of six to eight inches.

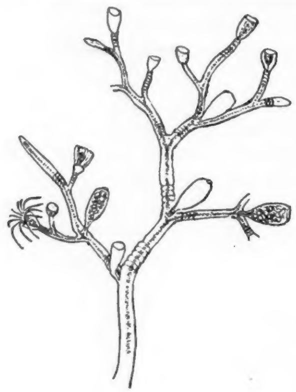

FIG. 17.—*Obelia commisuralis* McCr. (After Agassiz.)

Gonosome: Gonangia elongate, slender, obconical, opening by terminal, circular orifice arising from the base of the cone on a short conical neck. Medusæ when first liberated have sixteen marginal tentacles, four radial canals, beneath which later the gonads develop.

2, *O. dichotoma* Linn.

Trophosome: Colony rather small, stem slender, irregularly branched, annulated just distal to origin of branches, the latter annulated at irregular intervals. Hydrothecæ large, deeply campanulate, borne on annulated pedicels.

Gonosome: Gonangia axillary, slender and smooth, somewhat obconical, and similar to those of former species. Medusæ with sixteen tentacles, manubrium somewhat trumpet-shaped.

3, *O. flabellata* Hincks.

Trophosome: Stem filiform, alternately branching, giving the stem a somewhat zigzag character. Both stem and branches variously annulated. Hydrothecæ alternate, short, widely open and with entire margins, borne on tapering annulated pedicels.

Gonosome: Gonangia axillary, obovate, with tubular orifice. Medusæ?

4, *O. geniculata* Linn. (FIG. 18).

Trophosome: Colony inconspicuous, rarely attaining a height of more than an inch. Stem somewhat zigzag in form as in former species, but apparently jointed at each bend. Hydrothecæ obconical, rather short, with plain orifice, borne on short annulated pedicels.

Gonosome: Gonangia axillary, urceolate, borne on short pedicels. Medusæ discoid, with twenty-four tentacles when liberated, greatly increasing in number with age.

Habitat: Common along Massachusetts and north Atlantic coast, on Fucus and Laminaria.

5, *O. gelatinosa* Pallas.

Trophosome: Stems fascicled, rising from a fibrous hydrorhiza to a height of eight to ten inches. Branches opposite in pairs, which alternate with each other in vertical arrangement, presenting a verticillate appearance. Hydrothecæ small, borne on long slender, ringed pedicels, and having notched margins of a somewhat castellated form.

Gonosome: Gonangia axillary, ovate, flattened at distal end and provided with raised orifice. Medusæ with sixteen tentacles when liberated from gonangium.

6, *O. longissima.*

7, *O. bicuspidata.*

8, *O. bidentata.*

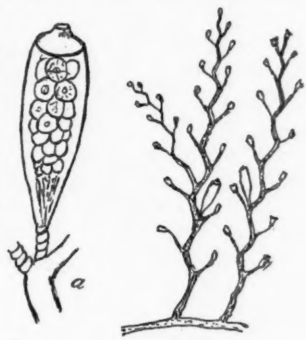

FIG. 18.—*Obelia geniculata* Linn. *a*, gonangium of same enlarged.

Species 6, 7, 8 are listed from Professor Nutting's records, but have not been taken by the present writer.

Campanularia Lamx. (in part).

The generic characters are fairly explicit under the synopsis of genera.

1, *C. caliculata* Hincks.

(Clytia poterium Ag.)

Trophosome: Stem simple, of variable length, bearing a single hydrotheca which is campanulate, with entire margin, and with a thick wall forming a sort of diaphragm within the lower part, thus giving the appearance of a double-walled cup.

Gonosome: Gonangia irregular, oval in shape, with undulating outline and with wide circular aperture. Medusoids extremely degenerate. Larvæ escaping as free-swimming planulæ.

Habitat: Massachusetts Bay, Nahant, Nova Scotia, on seaweed, etc.

2, *C. hincksii* Alder.

Trophosome: Stems rather long, mostly simple; hydrothecæ large, deep, almost tubular, the margins scalloped with castellated teeth.

Gonosome: Gonangia ovate, elongate, somewhat narrowed toward extremity, irregularly annulated throughout, borne on short, smooth pedicels. Medusoids degenerate; ova forming a central mass within the capsule.

3, *C. volubilis* Linn.

Trophosome: Stems usually simple, long and somewhat twisted. Hydrothecæ deep and sub-tubular, margins with shallow undulations.

Gonosome: Gonangia flask-shaped, smooth, with an elongate neck borne on short pedicels.

Habitat: Frequently found growing upon other hydroids, usually in deep water. Gulf of St. Lawrence, Massachusetts coast, etc.

4, *C. neglecta* Alder.

Trophosome: Stems regularly branched, delicate, filiform, branches pinnate, both stem and branches more or less annulated. Hydrothecæ narrow, deep, borne on annulated pedicels and with marginal teeth bimucronate.

Gonosome: Gonangia axillary or on short pedicels which are annulated, pear-shaped.

The colony is very minute and inconspicuous.

5, *C. verticillata* Linn.

Trophosome: Colony composed of erect, fascicled stems, irregularly branched. Hydrothecæ bell-shaped, rather large, deep, with from ten to twelve teeth about the margins, borne on annulated pedicels.

Gonosome: Gonangia flask-shaped, smooth, borne on short pedicels and terminating in narrow orifice.

FIG. 19.—*Campanularia amphora* Ag. (After Agassiz.)

6, *C. amphora* Ag. (FIG. 19).

Trophosome: Colony resembling in general aspects that of *Obelia commisuralis*, attaining in some cases a height of four to six inches. Hydrothecæ campanulate, with entire margins, borne on annulated pedicels.

Gonosome: Female gonangia elongate, somewhat obconical, borne on short annulated pedicels and opening by a terminal aperture. Male gonangia elongate, oval or spindle-shaped. Medusoids more or less degenerate, never becoming free; the male, according to Agassiz, attaining a higher stage of development than the female. The embryo escapes from the gonangium as a free-swimming planula.

7, C. *angulata* Hincks (FIG. 20).

Trophosome: Stems slender, slightly branched, strongly geniculate or undulate in habit. Hydrothecæ alternate, campanulate, with entire margins, borne on long slender pedicels which arise at each flexure of the stem or branch.

Gonosome: Gonangia somewhat ovate, obscurely wrinkled, and terminated by a broad aperture. Colony small, varying from ½ to ¾ inch.

FIG. 20.

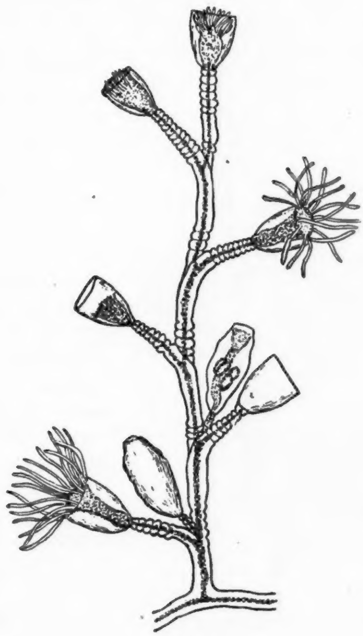

FIG. 21.

FIG. 20. — *Campanularia angulata* Hincks. (After Hincks.)
FIG. 21. — *Campanularia flexuosa* Hincks. (After Hincks.)

8, C. *flexuosa* Hincks (FIG. 21).

Trophosome: Stem flexuous, irregularly branched, annulated near the base and above the origin of branches. Hydrothecæ large, subcampanulate with plain margins, borne on long annulated pedicels.

Gonosome: Gonangia axillary, large, elongate, smooth, and borne on short annulated pedicels. Male gonangia sensibly smaller.

Professor Nutting has recorded the following species of which I have no data, and which therefore are merely noted.

C. minuta ; *C. Edwardsii* Nutting ; *C. calceolifera.*

Gonothyræa Allman.

1, *G. lovéni* Allman (FIG. 22).

Trophosome : Stems erect, somewhat flexuous, irregularly branched, and with annulations above each branch. Hydrothecæ deeply bell-shaped and with toothed margins, borne on short annulated pedicels.

Gonosome : Gonangia borne on short annulated pedicels, axillary, broadly obconical in outline.

Habitat : On fucus and other algæ, rocks, etc. Cold Spring Harbor, Woods Holl, etc.

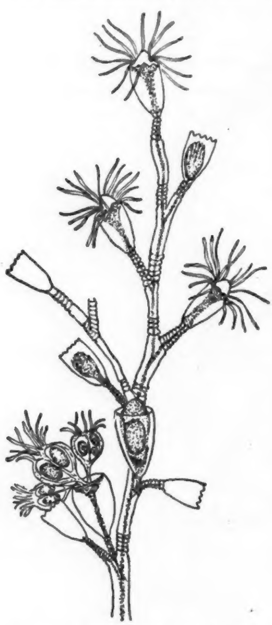

FIG. 22. — *Gonothyræa loveni* Allman. (After Hincks.)

2, *G. hyalina* Hincks.

Trophosome : Colony elongate, clustered, profusely branched, with flexuous stems giving off branches at each bend, "Branches erect, very tender and hyaline, sometimes of great length and much ramified." Hydrothecæ elongate, of delicate texture, with numerous marginal teeth and borne on annulated pedicels.

Gonosome : Gonangia oval, axillary, borne on annulated pedicels.

Habitat : On various hydroids, Tubularia, Halecium, etc. (Hincks).

3, *G. tenuis* Clark.

Noted from Nutting's list.

LAFŒIDÆ.

This family has been variously modified of late and by some replaced entirely. In the present synopsis I have chosen to follow in general the classification of Hincks, though recognizing its doubtful reliability in some respects.

Lafœa Lamx.

Stems simple or fascicled, attached by filiform hydrorhiza. Hydrothecæ tubular, with or without operculum. Gonangia oblong, often forming encrusting masses about the stem.

1, *L. dumosa* Flem. (Fig. 23).

Trophosome: Stem creeping, sometimes erect and fascicled; hydrothecæ tubular, margins devoid of teeth or operculum, usually sessile.

Gonosome: (?)

2, *L. calcarata* A. Ag. (Fig. 24).

Trophosome: Stems creeping, simple; hydrothecæ tubular, sessile.

Gonosome: Gonangia large, elongate, obovate or oblong, somewhat resembling those of certain campanularians. Medusæ large, transparent, with gonads suspended in folds beneath the radial canals; marginal tentacles numerous in mature specimens, only two when first set free.

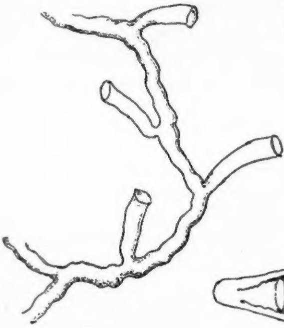

Fig. 23.

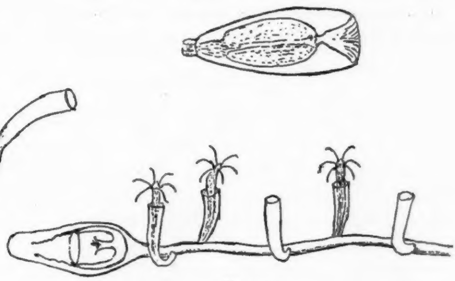

Fig. 24.

Fig. 23. — *Lafœa dumosa* Flem. (After Hincks.)
Fig. 24. — *Lafœa calcarata* A. Ag. (Adapted from A. Agassiz.)

Habitat: Usually parasitic upon sertularian hydroids.

3, *L. pygmæa* Alder.

Trophosome: Stem creeping; hydrothecæ minute, tubular, elongate, borne on very short annulated pedicels.

Gonosome: (?)

Habitat: Parasitic on various hydroids.

Halecidæ.

Of this family a single genus comes within the range of this synopsis: namely, the type genus, Halecium (Oken), the characters of which may be summarized as follows:

Trophosome: Colony more or less branched, attached by a creeping hydrorhiza. Hydrothecæ often shallow and disk-like, or funnel-shaped (hydrophores). In many species with double or triple margins due to

subsequent secretions as the hydranth grows, leaving the old hydrophore. In many cases the everted rim has on its inner margin a circle of small bright dots which are rather characteristic of the genus. Hydranths imperfectly retractile, elongate, and with conical hypostome.

Gonosome: Gonangia of varying aspects, showing distinctive differences between male and female and affording easy means of distinguishing the sexes. Medusoids imperfectly developed, never free.

1, *H. halecinum* Linn. (FIG. 25).

Trophosome: Colony erect, rather rigid, subflabellate in form. Hydrothecæ alternate, somewhat tubular in form, and with everted rims.

Gonosome: Gonangia borne in a series on the upper side of the branches; those of the male elongate, slender, somewhat spindle-shaped, tapering below

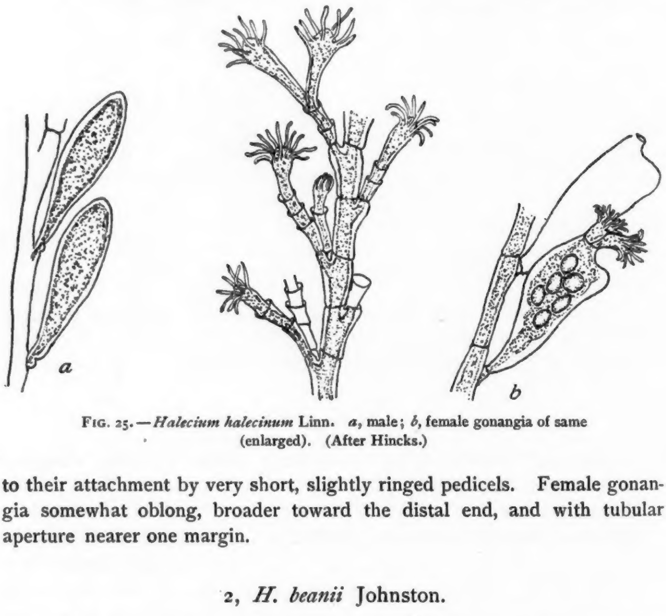

FIG. 25.—*Halecium halecinum* Linn. *a*, male; *b*, female gonangia of same (enlarged). (After Hincks.)

to their attachment by very short, slightly ringed pedicels. Female gonangia somewhat oblong, broader toward the distal end, and with tubular aperture nearer one margin.

2, *H. beanii* Johnston.

Trophosome: Colony of delicate, graceful form, somewhat dendritic, attaining a height of about two inches. Hydrothecæ with everted rims.

Gonosome: Gonangia arising from near the base of hydrothecæ; male, elongate oval; female, somewhat curved, with the aperture situated near the middle of the upper side.

3, *H. tenellum* Hincks.

Trophosome: Colony minute, extremely delicate; stems slender, often strongly annulated, branching irregularly. Hydrothecæ funnel-shaped and with everted margins.

Gonosome: Gonangia ovate, pedicellate.

4, *H. muricatum* Ell. and Sol.

Trophosome: Colony stout, dendritic, profusely branched, and with joint-like divisions, alternately from below which the hydrothecæ arise.

Gonosome: Gonangia ovate, borne on short pedicels, roughly marked with linear ridges of spinous processes.

Eastport, Me. (Verrill).

SERTULARIDÆ.

Synopsis of Genera.

SERTULARIA. Colony plant-like, stems more or less branching, jointed, attached by creeping hydrorhiza. Hydrothecæ in double rows, strictly opposite, usually devoid of operculum. Gonangia with plain margins.

SERTULARELLA. Colony resembling somewhat the former. Hydrothecæ in double rows, but distinctly alternate, with toothed margins and with an operculum composed of several pieces. Gonangia strongly annulated throughout, slightly dissimilar in the two sexes.

DIPHASIA. Colony more or less branching, stem jointed, hydrothecæ opposite, a pair to each internode and often with a valve-like operculum. Gonangia scattered, differing in shape in the two sexes, those of female large, often divided into segments above, male smaller and with central tubular aperture.

THUIARIA. Stem somewhat plant-like, jointed; hydrothecæ in double series sub-opposite, but deeply immersed in the substance of stem and branches.

HYDRALLMANIA. Stems flexuous or somewhat spirally inclined. Hydrothecæ alternate, placed on front of branches, and curved alternately to right and left.

Sertularia Linn.

Generic characters given above.

1, *S. pumila* Linn. (FIG. 26).

Trophosome: Stems straight or slightly curved, simple or branched; branches opposite; both stem and branches divided into short internodes, each bearing a pair of hydrothecæ, the latter opposite, tubular, and somewhat contracted toward the aperture, which faces outward and is more or less cleft or notched.

Gonosome: Gonangia more or less oval, sessile, with marginal rim. Male gonangia somewhat more slender, and regular in outline.

Habitat: One of our commonest sertularians, found attached to fucus, etc., between tide marks and in tide pools.

2, *S. cornicina* McCr.

Trophosome: Colony very small, composed chiefly of unbranched stems, which rarely attain a height of more than ½ inch. Hydrothecæ appearing as lateral emarginations with slightly divergent apertures. Hydranths slender, with about sixteen tentacles.

Gonosome: Gonangia?

The above description is condensed and modified from that of McCrady (*Proc. Elliott Soc.*, Vol. I, p. 204).

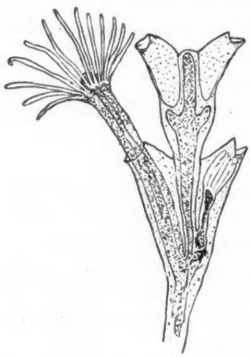

FIG. 26.—*Sertularia pumila* Linn. (After Agassiz.)

3, *S. argentea* Ell. and Sol.

Trophosome: Colony of bushy and slightly wavy stems, perisarc dark and horny; branching, alternate, and somewhat dichotomous. Hydrothecæ short, urn-shaped, tapering toward the free and divergent aperture, which is small and oblique.

Gonosome: Gonangia broad, obovate, tapering toward the base; aperture circular, and usually with two divergent spines.

Habitat: Usually from deeper waters, growing on shells, stones, etc., sometimes found near tide marks. Recorded from various points along the New England coast.

4, *S. cupressina* Linn.

Trophosome: Colony slender, elongated. Stems rather stout and straight, alternately branched and dichotomously sub-branching. Hydrothecæ tubular, transparent, somewhat alternate, and adherent throughout most of their length, slightly divergent toward the aperture, which is wide and bilabiate.

Gonosome: Gonangia elongate, tapering toward base, and with prominent spine at each side of the aperture, which is slightly raised and central.

Habitat: Less abundant than the former species, though with similar distribution.

Sertularella Gray.

Generic characters given in above synopsis.

1, *S. rugosa* Linn.

Trophosome : Colony small, simple, or sparingly and irregularly branched ; stems annulated. Hydrothecæ crowded, strongly annulated transversely, and with four marginal teeth.

Gonosome : Gonangia large, ovate, strongly annulated, and with a four-toothed aperture.

2, *S. gayi* Lamx.

Trophosome : Stems erect, with alternate branches, somewhat obliquely jointed. Hydrothecæ somewhat urn-shaped, one to each internode, usually wrinkled, and with narrower, divergent, four-toothed aperture.

Gonosome : Gonangia elongate, ovate, tapering toward the small, two-toothed aperture. Usually strongly annulated in upper portion, the lower smooth.

3, *S. tricuspidata.*

Trophosome : Stems slender, alternately branched, often bipinnate near the ends. Hydrothecæ cylindrical, smooth, slightly everted, with a three-toothed orifice.

Gonosome : Gonangia large, with strongly transverse ridges and with a plain, funnel-shaped opening.

FIG. 27.—*Diphasia fallax* Johnst. (After Hincks.) *a*, ♀ gonangium of same (enlarged).

Diphasia Ag.

1, *D. fallax* Johnston (FIG. 27).

Trophosome : Stems thick, sparingly branched, branches alternate, often terminating in tendril-like bodies. Hydrothecæ short, tubular, with upper part slightly divergent, and with wide, smooth orifice.

Gonosome: Gonangia differ in the two sexes. Male elongate, slender, tapering toward base and expanding toward orifice, which bears four stout spines. Female gonangium oval, deeply cleft above into four leaf-like segments, larger than male.

2, *D. rosacea* Linn.

Trophosome: Stems slender and delicate, branches alternate and with internodes constricted at the base. Hydrothecæ long, tubular, with upper portion free and divergent toward the aperture, which is oblique and entire.

Gonosome: Gonangia slightly different in the sexes; female pear-shaped, elongate, borne on short pedicels and marked with eight longitudinal ridges, each terminating above in a spinous process. Male somewhat curved toward base, with similar longitudinal ridges terminating in spinous teeth about the slender tubular orifice.

FIG. 28.—*Hydrallmania falcata* Linn. (After Hincks.)

Thuiaria Flem.

A single species of this genus comes within the present synopsis.

Thuiaria thuja Flem.

Trophosome: Stem and branches rather rigid, somewhat zigzag in shape, and annulated near the base. Perisarc black or very dark in color. Hydrothecæ smooth, ovate at base and tapering toward the distal end.

Gonosome: Gonangia smooth, pyriform, and with circular slightly emarginate aperture.

Hydrallmania Hincks.

Hydrallmania falcata Linn. (FIGS. 28, 29).

(Sertularia falcata.)

Trophosome: Stems flexuous, slender, sometimes spirally inclined. Branches alternate, regularly pinnate and plume-like, arising just above

each joint. Hydrothecæ tubular, closely appressed, arranged in rows along the pinnæ, and with plain oblique aperture.

Gonosome: Gonangia ovate, tapering toward the base, and with a tubular orifice.

Habitat: Shells, stones, etc., generally distributed from Grand Manan, Massachusetts Bay, and southward.

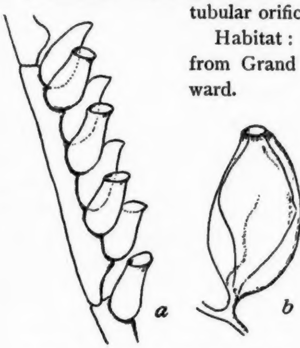

FIG. 29.—*Hydrallmania falcata* Linn. *a*, hydrothecæ; *b*, gonangium.

PLUMULARIDÆ.

Synopsis of genera. Modified and condensed from Nutting's Monograph of the Plumularidæ.

ANTENNULARIA. Colony more or less arbuscular, stem simple or branching, jointed, attached by massive hydrorhiza. Branching somewhat verticillate or scattered; hydrothecæ cup-shaped; nematophores trumpet-shaped. Gonangia borne in axils of branches, unilateral.

MONASTÆCHAS. Colony dichotomously branched, stem not fascicled, hydrocladia arising from upper sides of branches, otherwise resembling Plumularia, from which it differs in the entire absence of cauline hydrothecæ. Gonangia oval in shape and with terminal aperture.

SCHIZOTRICHA. Colony branching, branches pinnately arranged, hydrocladia often forked. Gonangia borne on stem or hydrocladia.

CLADOCARPUS. Stem simple or fascicled. Nematophores not trumpet-shaped, definitely fixed to hydrothecæ or branches. Gonangia borne on stem or hydrocladia.

Antennularia Linn.

1, *Antennularia antennina* Linn. (FIG. 30).

Trophosome: Colony growing in dense clusters of upright stems, often eight to ten inches high, stems simple or sparingly branched, obscurely jointed, each internode bearing a cluster of hydrocladia. Hydrothecæ small, cup-shaped, and with slightly everted margins.

Gonosome: Gonangia ovate, borne singly in axils of hydrocladia. Aperture subterminal.

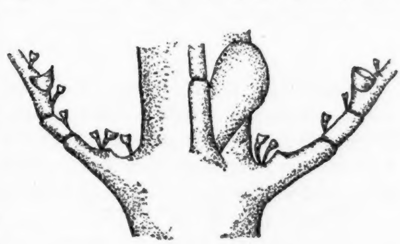

FIG. 30.—*Antennularia antennina* Linn. Portion of stem and hydrocladia (enlarged). (After Nutting.)

2, *A. americana* Nutting.

Similar to former, but usually from deeper water and apparently of exceedingly variable character.

3, *A. rugosa* Nutting.

Trophosome: Colony unbranched, attaining a height of six inches. Hydrocladia in verticils of six or eight, borne on stout processes of the stem and with proximal ends reinforced on the lower sides by a thickening of the perisarc. Internodes long and irregular, further subdivided by numerous irregularly disposed septal thickenings, which resemble joints, giving the appearance of many internodes, where in reality there is but one. Hydrothecæ small, short, cylindrical, and supported below by a thickening of the internode.

Monastæchas quadridens McCr.

Trophosome: Colony subflabellate in form, dichotomously branched, attaining a height of about six inches. Stem not fascicled, with indistinct internodes and branching at irregular intervals, those bearing hydrocladia being divided into long internodes, each of which bears a hydrocladium at its distal upper side. Hydrothecæ large, campanulate.

Gonosome: Gonangia sac-like, borne on short processes below hydrothecæ, and each protected by a pair of nematophores.

Habitat: Various stations along the North Atlantic coast, and from Marthas Vineyard southward.

Schizotricha Allman.

Hydrocladia pinnately disposed, often branching once or more. Two species come within the range of this synopsis.

1, *S. tenella* Verrill.

Trophosome: Colony branched dichotomously, attaining a height of about two inches. Stems clustered or fascicled, divided into alternately longer and shorter internodes, the latter bearing each a hydrotheca and a hydrocladium. Hydrocladium slender, often branched, proximal internodes short, and without hydrothecæ, which are subcylindrical.

Gonosome: Gonangia of curved shape, tapering at base and gradually enlarged toward the distal end, somewhat resembling cornucopiæ.

Habitat: Gay Head, Vineyard Sound, New Haven, Greenport, R. I., Woods Holl, Vineyard Haven.

2, *S. gracillama* Sars. (Fig. 31).

Trophosome: Stem sparingly branched, having a height of about two inches and somewhat fascicled. Branches divided into regular internodes, each of which bears a hydrocladium on a short, stout process near its distal end. Hydrocladia alternate, branching dichotomously twice or more beyond its proximal internode. Hydrothecæ small, cup-shaped.

Gonosome: Gonangia borne in pairs on the stems in the axils of the hydrocladia, and also at the forks of the latter, cylindrical in shape, tapering at proximal ends, sessile.

Habitat: Shallower waters, New England coast.

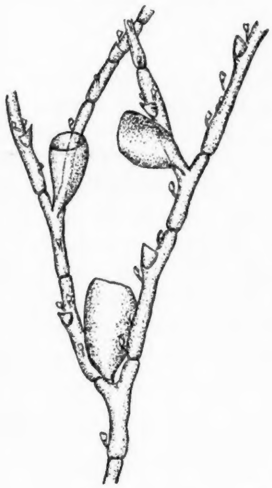

Fig. 31.

Fig. 32.

Fig. 31.—*Schizotricha gracillima* Sars. Branched hydrocladium (enlarged). (After Nutting.)

Fig. 32.—*Cladocarpus flexilis* Verrill. Portion of hydrocladium (enlarged). (After Nutting.)

Cladocarpus Allman.

Stem simple or fascicled. Hydrothecæ deep and with smooth margins or with lateral sinuations, and with one or two anterior teeth. A single species comes within the range of this synopsis.

C. flexilis Verrill (Fig. 32).

Trophosome: Colony long, slender, sparsely branching, stem not fascicled, attaining a height of about nine inches. Hydrocladia distinct, slightly sinuous, divided into rather slender internodes, each with a number of septal ridges back of hydrothecæ, which are deep, tubular, nearly straight, and with a single anterior tooth at the aperture.

Gonosome: Gonangia numerous, borne on stem and bases of hydrocladia, oblong-ovate, with latero-terminal orifice.

REVIEWS OF RECENT LITERATURE.

ANTHROPOLOGY.

Human Spines.[1] — The paper is, in the words of the author, "a description of forty-five anomalous human spines in the Warren Museum," and of a number of special parts of the spinal column from the same collection; it is also a discussion of the causes of the spinal variations.

The author describes five classes of spinal anomalies, namely:

1. Spines in which the number of præsacrals is normal, but in which there is an irregularity at the junction of the thorax and loins, or at the junction of the thorax and neck.

2. Spines in which the 26th is the *v. fulcralis*, but in which the 25th is not quite separated from it.

3. Spines in which there are more than 24 perfectly free præsacrals, the extra one being thoracic, or lumbar, or there being two extra præsacrals, one thoracic and one lumbar, the latter sacralized on one side, the 27th being the *fulcralis*.

4. Spines in which one or more præsacral vertebræ are imperfectly developed, one or more vertebræ being fused, the atlas being fused with the occiput, or the 24th being more or less sacralized.

5. Spines in which there is a præsacral too few: a vertebra being wanting in the loins, in the back, there being 12 pairs of ribs, the first pair being cervical and perfect on one side, the 24th being in all the groups the *fulcralis*.

There are further described cervical, rudimentary first thoracic, bicipital and tricipital ribs; fusion of atlas and occiput, of atlas and axis, axis and third cervical vertebra; a suppression of a cervical and an extra half vertebra.

The main facts brought out by the paper are (1) a lack of relation between the condition of the spine at one end of the thorax and that at the other, and (2) the frequency of "concomitant" variations on one or both sides of the spine.

[1] *Dwight, Thomas.* Description of the Human Spine, showing Numerical Variation, in the Warren Museum of the Harvard Medical School. *Memoirs of the Boston Society of Natural History*, vol. v, No. 7 (Boston, 1901), pp. 237–312, with figures.

(1) "If the undeveloped end of the 1st thoracic rib is a step towards the future, it would be reasonable to expect in the same spine a corresponding advance below the thorax. Conversely, if there is an archaic condition below the thorax, there should be an analogous condition above it. While there are cases that fulfill these conditions, they are quite lost in the multitude which do not, and which even present contradictory conditions at the opposite ends of the spine, being retrogressive at one end and progressive at the other."

These facts are in contradiction to Rosenberg's theory.

(2) The author points to the cases where "we see a tendency sometimes for the whole thorax to move forward (upward ?) by cervical ribs associated with absence of the last thoracic ones or with their existence in a rudimentary condition." "We also see cases in which, when the cervical rib on one side is distinctly larger than its fellow, the last rib on that side is either correspondingly smaller than its fellow, or even replaced by a pretty typical transverse process." These *concomitant variations* "may extend even further, so as to include the sacralization of one side of the last lumbar, or even the absorption of one side of the atlas into the occiput."

The causes of the variation : The author confesses his inability to show the original cause of the phenomenon. "It is clear, however, that the vertebræ at the junction of regions are particularly variable, and it seems hard to doubt that errors of segmentation may occur. The original error having occurred, there seems to be a tendency in the organism to reproduce the type as nearly as may be under the changed conditions ; to make as normal a series of regions as circumstances will permit ; and this tendency manifests itself to some extent independently in the two halves of the spine." For this tendency the author adopted the old and rather unsatisfactory theory of "the vital principle."

Professor Dwight closes his interesting work with the following additional deductions :

1. Variations occur in two ways : (1) by irregular development of the costal elements at and near the ends of the regions of the spine, and (2) by irregular segmentation through which there are more or fewer vertebræ than normal.

2. Variations of both kinds are variations around a mean. It is not impossible that some of them may be reversive ; that any are progressive is mere assertion.

3. Assuming the correctness of Rosenberg's studies in ontogenesis,

his view may account for some of the variations, but even in these cases something more is needed to explain the concomitant changes.

4. Variation of the costal elements at one end of a region is often associated with variation of an opposite nature of those at the other end. Several regions may be involved, and the two sides may vary independently.

5. Variations, which separately seem either reversive or progressive, generally lose that appearance when the whole spine is considered.

6. After the occurrence of the original error in development there is a tendency for the spine to assume as nearly as possible its normal disposition and proportions. This, as do also concomitant variations and indeed all development, implies a "vital principle."

These deductions of the author naturally invite discussion; but it will be of advantage if this be deferred until the material bearing on the points in question is still more abundant and the observations extended. Conclusions of this nature apply not only to the part under consideration but largely to the whole skeleton.

A. H.

Notes. — Four "Cruciform Structures near Mitla" are described by Mr. M. H. Saville in Vol. XIII of the *Bulletin of the American Museum of Natural History.* After a scholarly summary of the history of previous explorations at Mitla the author confines his attention to the cruciform burial chambers which are unique in form and surpass all other tombs in Mexico or Central America in size and in beauty of stone work.

"A Bilateral Division of the Parietal Bone in a Chimpanzee; with a special Reference to the Oblique Sutures in the Parietal," is the subject of a paper by Dr. Aleš Hrdlička, appearing in the same volume. It contains a detailed description of the skull of an adult male chimpanzee, with a discussion of the important problems connected with the abnormal parietal sutures. An oblique suture, the author believes, can be attributed to only three possible causes, as follows: an early fracture, a persistence of the original separation between the two centers from which the bone is developed, and a coexistent difference between their relative positions; the existence of a supernumerary third center of ossification. The brochure is illustrated by six outline drawings.

In the *Report of the Museums Association of the United Kingdom* for 1898 Mr. Harlan I. Smith advises an "ethnological arrangement

of archæological material," and suggests a classification under thirteen main divisions of such material, with a view to illustrating ancient tribal life and ethnology. This method would make the specimens aid in solving problems and would find a use for many now discarded as unworthy of attention.

The *Report* for 1899 contains a paper by Mr. Smith upon "the preservation of local archæological evidences," showing the danger of their obliteration by man and nature, and the necessity of systematic explorations in this country as well as in foreign lands. More accurate and complete records should be kept by means of indices and catalogues. Mr. Smith makes suggestions for local work under the auspices of state universities and historical societies.

An interesting example of "psycho-physical study" is given in Mr. Arthur MacDonald's "Emile Zola," reprinted from *The Open Court*, August, 1898. This study was made by a number of French specialists, and the result published with the approval of the subject. Among the characteristics investigated are antecedents, mental evolution, physical peculiarities, the nervous system, ideas, sentiments, and will. This empirical method is employed in order that we may come to have somatology of the living as well as of the dead, and thus gain a knowledge that will be of practical use in ameliorating social conditions.

In the *Bulletin* (Vol. VIII, No. 2) of the French Society of Anthropology, M. Zaborowsky discusses at some length the problems of the racial unity and the place of origin of the Slavs. He concludes that:

1. The Slavs of the North came from the region between the Danube and the Adriatic. They were related to the neighboring inhabitants of the terramare of Emilia. The migrants may have been drawn toward the north by the trade in amber.

2. They passed the Carpathians through the valleys of the Oder and Vistula, following especially the latter to the vicinity of the Baltic, where they developed an independent culture.

3. The Slavs introduced the custom of cremation, until then unknown. They brought metals and glass; iron was used for ornament only.

4. They formed a branch or included the tribes of the Venedes of the Adriatic; the name Venedes dates back in the Baltic region to the fourth century before our era.

5. By their dominant characters they approach the French Keltic type. The southern Slavs are dark and brachycephalic. To the

northward of the Carpathians they encountered a neolithic blond population which they absorbed and in part perpetuated in certain regions.

6. Upon the Oder, the lower Vistula, and along the Baltic coast, where they have pushed back the Finns toward the east, their culture was modified by contact with the Germans from Scandinavia.

F. R.

ZOÖLOGY.

Evermann and Marsh on the Fishes of Porto Rico. — One of the most thoroughly admirable of faunal works is the report on the *Aquatic Resources and Fisheries of Porto Rico*, just published by the United States Fish Commission. The authors are Dr. Barton Warren Evermann and Millard C. Marsh.

In this work are given full descriptions of 291 species, arranged systematically, with analytical keys and numerous figures in the text. A general discussion of the waters and of the geographical features of the island is given by Dr. Evermann, and a chapter on the fish trade and fishing methods by William A. Willcox.

The work is illustrated by 49 colored plates, by C. B. Hudson and A. H. Baldwin. The accuracy and excellence of these plates cannot be too highly praised. Without invidious comparisons we may doubt if any plates of fishes ever published excel in fineness of coloration some of these (as the Nassau Grouper, Plate XII, and the Red Hind, Plate XIII) by Mr. Hudson.

The nomenclature and definitions of groups are taken chiefly from Jordan and Evermann's *Fishes of North America*, and the new species are mostly described in the final appendix to that work.

Those not thus included are the following:

Aphthalmichthys caribbæus, Gill and Smith, San Geronimo.	*Sphagebranchus ophioneus*, Mayaguez.
Lycodontis albimentis, Culebra Island.	*Apogon sellicauda*, Culebra Island.
Mycteroperca bowersi, Culebra.	*Neomænis megalophthalmus*, Puerto Real.
Scorpæna albifimbria, Culebutas.	*Scorpæna bergi*, Mayaguez.
Pontinus beanorum, San Juan.	*Emblemaria pandionis*, Isabel Segunda.
Citharichthys arenaceus, Mayaguez.	*Halieutichthys smithi*, Mayaguez.

The name Peprilus is substituted for Rhombus, preoccupied in mollusks. A few other changes in the nomenclature, adopted from Jordan and Evermann, will be found necessary. These may be

briefly noted without statement of the reasons: Sardinia for Clupanodon, which should be restricted to the group in Japan and China, lately named Konosirus; Anchovia for Stolephorus, which was based on a Japanese Spratelloides; Esox (Esocidæ) instead of Lucius; (the type of a Linnæan genus, according to Linnæus," is the best known European or officinal species"); Syngnathus for Siphostoma, the same rule covering these cases; Bodianus should replace Harpe, the genus called Bodianus by Jordan and Evermann standing as Cephalopholis; Dipterodon should replace Neomænis, if the latter is really distinct from Lutianus; Eupomacentrus is probably not distinct from Pomacentrus; Tropidichthys should replace Canthigaster, the latter a bare definition without species. Probably Carapus must replace Fierasfer. Lepisoma must take the place of Labrisomus, which replaces Gobioclinus. Probably Ichthycallus should be used instead of Iridio.

D. S. J.

Studies of Animal Life.[1] — In this new series of laboratory exercises for use in high schools — the outgrowth of experience in the schools of Chicago — the authors have aimed to make the practical work of elementary zoölogy a study from the view-point of animal life, interpreting structure in the light of activity. While the outlines for the study of the activities of living animals are as extensive as is probably practicable for most schools, by far the greater part of the laboratory work is a study of structure. Students are not expected to dissect, but many points of internal structure are to be demonstrated from permanent preparations.

In the form of its outlines the book is an example of the reaction from the older manuals, — which consisted of description to be verified by the students, — in that it contains numerous questions, along with a minimum of description and guiding information. Some of the questions are of doubtful value in elementary zoölogy, for example: "Why are there no fresh-water echinoderms?" "Is there anything about the life history of man to suggest the metamorphosis of insects?" "What traces of an invertebrate exoskeleton are still present in man?"

In order "to develop the subject of the evolution of life from simple to complex forms," the authors follow the so-called logical order and begin with the Protozoa, because "high-school pupils are not more familiar in any true scientific sense with higher forms." If this

[1] Walter, H. E., Whitney, W., and Lucas, F. C. Boston, Heath & Co., 1900. 106 pp. *Teacher's Book of Suggestions*, with 31 pages.

be true, there is inconsistency in some questions in the first lessons; for example: "Is there evidence that Paramœcia can breathe?" "Has the Amœba a stomach?" Such questions are meaningless unless the pupil has some scientific knowledge of structure and functions in higher forms.

On the whole, the spirit and plan of most of the lessons may be commended. Many teachers will welcome this as a laboratory guide which aims to meet the popular demand for less study of comparative anatomy and more about animal life in secondary education.

M. A. B.

Human Physiology. — Dr. Wm. D. Zoethout's translation of Schenck and Gürber's *Human Physiology*[1] places within reach of the English-reading student one of the best of the shorter German physiologies. The translation is from the second German edition and follows the original closely. After a brief introduction on general physiology, the subject-matter is arranged under three heads — metabolism, the transformation and setting free of energy, and reproduction and development. The treatment is as modern as is consistent with general soundness. Thus we are told that "a solution tastes the more sour the greater the number of hydrogen atoms replaceable by metals contained in the unit of volume," a statement which includes all that is up to date without involving the reader in the dissociation hypothesis. Although the text of the book has been compiled with great conciseness and care, it is to be regretted that the illustrations are so inadequate. Thus the figure showing the general anatomy of the ear as copied from Helmholtz, and the positively inaccurate drawing of the cross-section of the lamina spiralis membranacea are scarcely justifiable. Nor is there good reason why the olfactory epithelium should be illustrated by a figure from Max Schultze, when such work as that done by Retzius, Van Gehuchten, and others is so readily accessible. Such defects, however, are small compared with the merits of the volume, which should be in the hands of every medical student and every teacher of elementary physiology.

P.

Korschelt and Heider's Embryology of Invertebrates. The fourth part of the English edition of Korschelt and Heider's *Ent-*

[1] Schenck, F., and Gürber, A. *Outlines of Human Physiology.* Translated from the second German edition by Wm. D. Zoethout. New York, Henry Holt & Co., 1900. viii + 339 pp.

wicklungsgeschichte der wirbellosen Thiere completes the translation of this monumental work.[1] As in the second and third parts, the translation has been done by Matilda Bernard, and the revision and editing by Martin F. Woodward. The present part gives an account of the embryology of the mollusks, the tunicates, and Amphioxus, and in the groups covered agrees with the third part of the German edition except in the omission of the chapters on the brachiopods and the Bryozoa, which the translators had previously placed in their second part. The third part of the German edition appeared in 1893; the translation, therefore, is unfortunately some seven years late. This has put on the editor the heavy task of supplying the more recently acquired information on the groups under consideration. Mr. Woodward has wisely refrained from rewriting the third portion of the work, and has attempted to bring it up to date by employing footnotes and adding to the literature lists, as in the former part. While this is perhaps the best way out of the difficulty, it does not seem to have been employed very successfully in this last part. As an example, the chapter on Amphioxus may be cited. Our advance in the knowledge of the embryology of this form is indicated in some seven notes, none of which give very extensive information. The appendix to literature for this chapter contains some fifteen new titles. As these presumably cover the period from 1893 to 1900, the list is obviously incomplete. One misses any reference to Lwoff's completed paper on the germ layers (1894), Legros's note on the morphology of the sexual glands (1895), MacBride's note on germ layers (1896), Garbowski's discussion of the mesoderm (1898), Klaatsch's account of the structure and development of the tentacles (1898), Lankester's note on the development of the atrial chamber (1898), and Legros's description of the development of the buccal cavity (1898), contributions which, judging from the composition of the literature lists in the German edition, should have been recorded. Incidentally it may be mentioned that of the names given in this appendix Hamman is substituted for Hammar and the capitalization of MacBride is unsteady. On the whole, the additions made by the editor do not show the high standard of work characteristic of the German original. The presswork, particularly in connection with the illustrations, retains more or less of the muddiness of the earlier parts. Notwithstanding these shortcomings,

[1] Korschelt, E., and Heider, K. *Text-Book of the Embryology of Invertebrates*, vol. iv. Translated by Matilda Bernard, revised and edited by Martin F. Woodward. New York, The Macmillan Company, 1900. xii + 594 pp., 312 figs.

the translation is generally so well done that the work, now that it is completed, cannot but be a boon to the English-reading student.

P.

Heart-Beats in Salpa. — The pulsation of the heart in three species of Mediterranean Salpas has been exhaustively studied by L. S. Schultze.[1] As is well known, the hearts of these animals beat first in one direction and then in the other. A complete set of *advisceral* or of *abvisceral* beats constitutes a *pulsation series.* The intervals between pulsation series are known as *pauses.* An advisceral pulsation series and its pause, followed by an abvisceral series and its pause, form a *compound heart period.*

The numbers of beats in pulsation series were so extraordinarily variable that a normal number could not be found. The total number of abvisceral beats may be considerably more or less than that of the advisceral beats; thus in one case 247 abvisceral beats corresponded to 100 advisceral beats, and in another 237 abviscerals to 523 adviscerals. The rates of the two sets of beats were, however, very close; thus 100 abvisceral beats were accomplished in 175 seconds, and the same number of adviscerals in 174 seconds. As the water in which the animal was kept lost oxygen, the rate of beating increased; thus an individual's heart, which at the beginning of the experiment beat 100 times in 208 seconds, after six hours beat the same number of times in 148 seconds. Of the three species studied, the two larger ones, *Salpa africana-maxima* and *Cyclosalpa pinnata*, had an average rate of 26 to 30 beats per minute; the smaller, *Salpa democratica-mucronata*, 107 per minute. The pauses between ad- and abvisceral series varied from 1 to 4 or occasionally 5 seconds.

Each heart-beat is a peristaltic wave that sweeps over the heart from one end to the other. Usually a new wave appears at one end before the old one has passed off at the other, and sometimes as many as seven waves may be counted on a heart at once. Krukenberg believed that the two ends of the heart were physiologically very different, and that nicotine and hellebore affected the advisceral pulsations only, the former diminishing, the latter increasing them. Schultze, however, found that these poisons influence the ab- as well as the advisceral pulsations, and thus demonstrated that the ends of the heart were not in this respect dissimilar.

[1] Schultze, L. S. Untersuchungen über den Herzschlag der Salpen, *Jenaische Zeitschr. f. Naturwissenschaften*, Bd. xxxv (1901), pp. 221–328, Taf. IX–XI.

The source of the stimulus for the contraction of the heart muscle was sought for in several ways. An isolated heart was found to be capable of beating regularly in either direction. Stimulation of the animal's brain had no effect on the heart-beat. Removal of the brain reduced the rate, but this was shown to be due to the loss of substance suffered by the animal and not to the removal of the brain. The filling of the heart with blood was shown not to be necessary for its contraction. As small fragments of the heart muscle continued to contract rhythmically, and yet on examination showed no evidence of nerve fibres or of ganglion cells, Schultze concluded that the motor stimulus for the action of the heart muscle must be generated exclusively by the metabolism of that muscle itself.

The alternating action of the heart depends on the capacity of its muscle to transmit the stimulus to contraction directly from fibre to fibre and on the varying rhythm of the two ends of the heart. In moribund individuals both ends of the heart may at times give rise to contraction waves simultaneously. These usually meet near the middle of the heart and neutralize one another. In normal individuals the rhythm at one end is so much more rapid than that at the other that this rhythm asserts itself for the whole heart. When, however, the muscle tissue of the given end becomes somewhat exhausted by continued action and thereby reduces its rate of contraction, the muscle substance of the opposite end, having recovered from the effects of its own previous action, may be able to establish a more rapid rate than its opponent, and thus the center of propagation is transferred to the recuperated end. Hence the quiescence of a given end permits that end to recuperate till its own rhythm can supersede that of the opposing end, and its action gradually exhausts it so that its opponent in turn will be able to gain the ascendency.

P.

Flies as Carriers of Disease. — Dr. L. O. Howard, in a recent paper,[1] has presented the possibilities of the transmission of disease by flies in a particularly striking manner. A large number of flies, representing many species, were bred from human excrement. Those seen visiting the same material were collected. Then collections were made in dining-rooms and pantries, and many sheets of sticky fly-paper examined to see what species commonly occur in

[1] A Contribution to the Study of the Insect Fauna of Human Excrement, *Proc. Wash. Acad. Sci.*, vol. ii (1900), pp. 541–604.

houses. By comparing the two series, those visiting and bred from excrement and those found in houses, it is at once apparent what species are liable to carry disease germs. The results show that practically all of the house flies occasionally breed in or visit human excrement. It is thus possible that almost any house fly may carry the germs of typhoid fever. The next step in this process, *viz.*, to find out by experiment whether flies actually carry germs on their tarsi and labellæ, was not investigated.

No less than thirty-six species of flies were reared from excrement, and forty-one other species captured visiting the same material. Among those bred were the common house fly (*Musca domestica*), and the pomace fly (*Drosophila ampelophila*). The latter is an especially dangerous species, as it not only frequents houses, but also occurs on grapes and other fruits exposed on the market.

In the course of the work, many new and interesting observations of purely scientific value were made on the life history of various species. A large amount of the disagreeable work was performed by Mr. F. C. Pratt, and the determination of the flies rests on the authority of Mr. D. W. Coquillett. N. B.

Trematode Fauna of Egypt.[1] — Just as the earlier works of Looss marked a new epoch in the study of the comparative anatomy of the distomes, so the present paper is destined to be the starting point of a movement toward the rational dismemberment of an ancient and honorable genus — Distomum. Not that others have failed to recognize its heterogeneous character, or to attempt its dissolution, but that up to the appearance of the paper under discussion no one has indicated a reasonable way to the end desired. Many authors have recognized groups of forms whose relationship was evident, and yet have failed to give such groups their true position as genera, or have seized upon single and insufficient characters to delimit them. Thus Rudolphi endeavored to employ external features, which in a group of such uniform exterior does not suffice; Dujardin selected a single feature, the character of the alimentary canal, for the major part of his genera, while both Diesing and Monticelli erred in the same direction. To be sure, certain small groups were recognized and set off from the remainder, but the systems proposed have never met general acceptance, probably

[1] Looss, A. Weitere Beiträge zur Kenntniss der Trematoden-Fauna Aegyptens, zugleich ein Versuch einer natürlichen Gliederung des Genus Distomum Retzius, *Zool. Jahrb.*, Abt. Syst., Bd. xii, pp. 521–784, 9 pls.

because of their inadequacy and of the heterogeneous character of the genera so formed. Then even the groups which were best made were taken as subgenera rather than in their true place as genera, and even subfamilies, which Looss is unquestionably the first to recognize in any broad way. This view does not in the least underestimate the admirable work of Braun and Lühe, which has appeared almost synchronously with that of Looss, and which, though dealing with fewer forms, furnishes evidence of the naturalness of the proposed dismemberment by the independent selection of identical groups.

Looss discusses first the law of priority in relation to helminthology, and advocates on cogent grounds the dating of generic names in this field from Rudolphi, "the Linnæus of helminthology." Though much to be desired, his proposal must still be regarded as impracticable in view of the close relation of synonymy in all groups. Looss protests strongly, and, most will admit, rightly too, against the use of conjecture in restoring old generic names and cities from Rudolphi Hemiurus and Echinostoma as recognizable and evidently good genera, with Sphærostoma as unrecognizable and Schisturus which depends upon pure conjecture. The law of priority is based upon the legal presumption that the literature is available everywhere, but a comparison of original specimens is not called for, since they exist, if at all, in a few places at most. The replacement of specific names, already well fixed, by comparison of the originals is hence in violence with the wording of the law ; if, however, it is to be carried out, general interests demand the earliest possible revision of all originals, since in this way the least disturbance will be produced. Names of species which do not exist in original specimens and which are not recognizable should be dropped at once so as not to burden the literature further. Looss then refers to the custom of Rudolphi in citing unknown parasites by the name of the host in genitive; *e.g.*, *Distoma meropis*, which should be interpreted as "a distome from Merops," but which, as the author wrote in Latin, has the outward form of a generic and specific combination. Such names are pure *nomina nuda*, since a diagnosis is lacking and were so regarded by the author, since he never used a genitive as a specific name, and since he also never omitted the "R." which is lacking after these, from the new species actually described.

The second section of the paper on the taxonomy of the distomes opens with a discussion of previous efforts in this direction, and of the great disparity in form and structure between Bilharzia,

Apoblema, and other forms. For the diœcious distomes a new family, the Schistosomidæ, is created, and the remainder, constituting many subfamilies, is left in the family Distomidæ. Since, however, the genus Distomum is nonexistent, this ought to have been changed to Fasciolidæ. A similar change is necessary with the name Monostomidæ, but what name shall be used in its place is not now clear.

Looss then gives the following scheme of the classification as emended, in connection with which it should be noted that there are numerous genera whose position even yet is a matter of doubt, and that this is not regarded by the author as in any sense a complete system :

A. Aspidocotylea Mont.
(remains unchanged)
Metastatica Lkt.
B. Malacocotylea Mont.
Family HOLOSTOMIDÆ Brds.
(remains unchanged)
Digenea s. str. Lkt.
Family DISTOMIDÆ Mont. (partim)
Subfamily Amphistominæ Looss (= Family AMPHISTOMIDÆ Mont.)
" Fasciolinæ Lss.
" Omphalometrinæ Lss.
" Opisthorchiinæ Lss.
" Echinostominæ Lss.
" Cœnogoniminæ Lss.
" Pnilophthalminæ Lss.
" Lepodermatinæ Lss.
" Gorgoderinæ Lss.
" Brachycœliinæ Lss.
" Pleurogenetinæ Lss.
" Cephalogoniminæ Lss.
" Dicrocœliinæ Lss.
" Syncœliinæ Lss.
" Heterolopinæ Lss.
" Urogoniminæ Lss.
Family (inquir.) RHOPALIADÆ [1]
" SCHISTOSOMIDÆ Lss. { Koellikeria Cobbold, Schistosomum Weinland, Bilharziella n.g.
" GASTEROSTOMIDÆ Braun
" DIDYMOZOONIDÆ Mont.
" MONOSTOMIDÆ Mont.
} Remain unchanged

[1] According to the recent investigations of Braun (*Zool. Anz.*, Bd. xxiii, p. 27) closely related to the Echinostominæ and consequently not of family rank.

According to Looss the formation of a special genus is warranted when a certain definitely circumscribed complex of characters can be recognized in two forms which also agree in other respects ; yet genera may be founded on single forms of evidently isolated structure. While general appearance is of value, yet internal anatomy is the real basis of subdivision, and just this is, in fact, little known, partly at least owing to ignorance regarding the relative importance of characters. Among the most weighty generic characteristics are the copulatory organs which show the following types : (1) No muscular cirrus sac closed proximally and distally about the duct and seminal vesicle, together with the constant, if often weakly developed, prostate which lies (*a*) free in the parenchyme, or (*b*) enclosed in a connective-tissue covering open at both ends ; (2) a closed muscular cirrus sac which encloses (*a*) the genital sinus, *i.e.*, the more or less elongated common terminal portion of both male and female ducts, or (*b*) only the end of the male duct. Here again the cirrus sac may enclose (*a*) seminal vesicle, prostate, ejaculatory duct, and protrusible cirrus, or (*b*) only the last three, the vesicle lying in the parenchyme, or (*c*) the prostate also is free, while only the duct and the cirrus are enclosed in the sac. The course of the uterus in the body is also an important generic character, while the size of the eggs is uniform within narrow limits in any genus. Of specific value are the size and form of organs in detail, the extent of the vitellaria, a very constant feature in any species, and similar details.

In the section treating of the characters of the subfamilies and genera one finds a great variety in manner of treatment. Most groups are considered *in extenso* with full-faced headings which claim immediate attention, but there are those which are introduced in the middle of a topic under another heading, or even rarely one finds a new genus thrown in parenthetically which, in the absence of key and index, makes its discovery difficult. Still the work is generally free from such slips, and the absence of a key is attributable to the often repeated assertion of the author that this is a fragment and not a finished system, having for its primary object the demonstration of the existence of natural groups of family and generic rank within the limits of the old genus Distomum Retzius.

From this section, as well as from the fourth and last, which contains a description of the new and little known species that have been studied by the author, it is hopeless to give here anything regarding the wealth of descriptive and comparative matter which is offered. It is not too much to say that no other helminthologist is

the equal of Looss in deciphering, delineating, and comparing the anatomical structure of trematodes, and it would be hard to find, save in his own work, the equal of the nine plates he has given to illustrate this work. Some mention is made of a total of eighty-four genera, including twenty-three old and sixty-one new; of the latter, three are clearly antedated by names proposed by Braun, five correspond to groups named by Lühe in a publication of identical date,[1] and four are provisional. Among the fifty-two species described twenty-four are new. One can only regret that the author did not give an index or table of contents, if debarred from forming a key by the incompleteness of his system. As it is, reference to any section or topic is not an easy matter. It may also be said that in rare instances the author fails to apply the principles he has laid down, without giving any reason for the exception; but some slips are unavoidable in a work of such magnitude, and do not detract from its permanent value. Though Looss disclaims having formed any complete system, his work comes nearer that than any one else has yet reached, and will be the foundation on which such a system is to be built.

H. B. W.

BOTANY.

Primitive Algæ and Flagellata.[2] — In reviewing Dr. Blackman's paper, the writer has not mentioned the authorities for the arrangement given therein, which may be found on reference to the paper itself. The article is of the nature of a review of recent work, and the following is but a condensation of its most important points.

The older arrangement of the Chlorophyceæ, given by Wille in Engler and Prantl's *Pflanzenfamilien*, is largely an artificial one, and consequently subject to changes. Of the three groups named by him, the Siphoneæ, Confervoideæ, and Protococcoideæ, only the first

[1] It appears to me clear that both the intent and the wording of the rules covering the choice in case of synchronous appearance of different names for the same forms call for the preference of the extended discussion over the preliminary notice, certainly in all cases where types are named. Under this interpretation Looss's names stand as against Lühe's, save for Dolichosomum, which is preoccupied, and hence gives way to Ithyogonimus Lühe rather than to Dolichodesmus Looss (*Zool. Anz.*, Bd. xxiii, p. 603) of later date.

[2] Blackman, F. F. The Primitive Algæ and the Flagellata, an Account of Modern Work bearing on the Evolution of the Algæ, *Annals of Botany*, vol. xiv, No. lvi (December, 1900), p. 647.

is a natural one. According to Blackman, the green algæ may be considered to originate from two flagellate forms, Chlamydomonas and Chloramœba. From the first type three divergent lines of ascent go off: one leading to Volvox, including the type of motile cell aggregations, another ending in the so-called unicellular Siphoneæ. The third, by far the largest and most important, is called the Tetrasporine type, including forms of non-motile cell aggregations, the main stem of which leads through the simple filamentous forms to the branched Coleochæte, and finally, it is to be supposed, to the higher plants. The Ulvas are properly placed as a specially developed side branch. The always perplexing Conjugateæ are indicated as forming a possible fourth line of ascent from the Chlamydomonas type.

The green algæ which arise from the second flagellate form, Chloramœba, include Ophiocytium, Conferva, and finally the Botrydium forms. It is considered that the gametes of these have in reality two cilia, not one, as previously believed. They are included under the head of the Confervales (Borzi), a title not coincident with that used by other authors, and, with their flagellate ancestors, form a group called the Heterokontæ.

The Phæophyceæ are derived from a brown flagellate, Chromulina, allied to the green Chloramœba. This is widely different from the older view, which recognized the simplest Ectocarpus type as the most primitive brown form. Phæocystis, a form on the border line between algæ and flagellatæ, is taken as the next step in the direction of plants, and is connected with the recently described undoubted algæ forms, Phæothamnion and Pleurocladia, and thence with the Ectocarpus type. The Piatones constitute a side branch from Chromulina.

The red seaweeds, it is suggested, find their origin in a flagellate form (Rhodomonas), which is said to possess a chromatophore of true Floridian red color.

However much one may or may not agree with the conclusions, the paper is a suggestive one and a valuable review of the status of the subject. The changes suggested regarding the Chlorophyceous algæ seem certainly to be in the right direction, except that the connection of the Botrydium forms and Conferva type is not very apparent. As to the brown algæ the identity of the flagellate ancestor does not seem absolutely certain and convincing. A flagellate ancestor for the red seaweeds is a matter of such doubt that, as the author says, it is no more than a suggestion which he makes. H. M. R.

Spermatozoa of Ferns.[1] — This account considerably extends the hitherto published work of Pfeffer and others, and is a valuable contribution to the knowledge of chemotaxis. Buller has found that in addition to malic acid and certain malates, experimented with by previous authors, other substances also exert a positive chemotactic influence on the spermatozoids of ferns. Various tartrates, oxalates, phosphates, and salts of potassium (all substances to be found in cell sap) have an attractive influence. Pfeffer's negative results with such substances are ascribed in the case of organic salts to the use of too dilute solutions; in inorganic salts to the fact that mixtures (*e.g.*, plant ash) were used. Nevertheless, the opinion of Pfeffer that it is a malate which attracts the spermatozoid to the archegonium in ferns is substantiated, by reason of the high degree of concentration required by other salts. Malic acid and its salts attract spermatozoids about fifty times more strongly than do other substances. That it is not free malic acid which is found in the cell sap of the archegonia seems probable in that Pfeffer determined no acid reaction in the exudation, and from the fact that malic acid alone is decidedly poisonous to the spermatozoids.

The fact that the diethylester of malic acid is indifferent indicates an explanation of the chemotactic influence on the basis of chemical dissociation, since the afore-named substance is undissociated in solution, whereas in malic acid and the malates the negative radicle is free as an ion. But at the same time, while it is shown that other undissociable substances, like cane sugar, grape sugar, etc., do not attract the spermatozoids of ferns, it is known that one at least (*i.e.*, cane sugar) does attract those of the mosses, while several attract certain bacterial forms. This fact is mentioned, but no explanation is attempted, beyond suggesting the possibility that some undissociable substances may be found which do exert a positive chemotactic influence on the spermatozoids of ferns. It is then the case, that while certain substances (*e.g.*, malic acid) may be indifferent in an undissociated form, other substances attract in some cases, although there is no dissociation of the molecule. This would naturally hinder at present the drawing of any general conclusions regarding the relation of chemotaxis and dissociation.

The fact that the spermatozoids of *Gymnogramme mertensii* and

[1] Buller, A. H. R. Contribution to our Knowledge of the Physiology of the Spermatozoa of Ferns, *Annals of Botany*, vol. xiv, No. lvi (December, 1900), p. 543.

other ferns come to rest upon the withdrawal of water from their contents is also considered. The swarm period of the spermatozoids of the above-named fern has been determined to be two hours, — a much longer time than reported in previous cases, — during which period the starch stored up in it disappears. H. M. R.

The Flora of Celebes. — The interest which American botanists are likely to feel in the flora of the Pacific Islands in consequence of our occupation of the Philippines makes Dr. Koorders' report[1] on Minahasa, the northeastern horn of Celebes, of more than passing importance to us. In addition to physiographic and similar data this volume, which forms one of the regular series of Mededeelingen issued from the Botanical Garden at Buitenzorg, gives a critical review of what had previously been written on the flora of Celebes, an annotated catalogue of the spermatophytes and pteridophytes known to occur in the island, descriptions of a number of new species, and full indices to the popular and scientific names of the plants, as well as chapters on the economic uses of many of the species and tabulations of plants yielding the more important useful products. Unfortunately the text is in Dutch, but diagnoses of new species are in Latin, and there are frequent annotations in German. T.

Notes. — The announcement for the Fourteenth Season of the Department of Botany of the Marine Biological Laboratory at Woods Holl has just been issued. The work will commence on July 3 and continue for six weeks. Courses have been provided in Cryptogamic Botany by Dr. Davis and Dr. Moore; in Phanerogamic Botany by Dr. Charles H. Shaw, and in Plant Physiology by Dr. R. H. True. Plant Cytology will be under the direction of Dr. Davis and Mr. Lawson, and in addition to the regular class work provision will also be made for a series of special lectures. Announcements and further information may be obtained from Dr. Bradley M. Davis, University of Chicago.

The *Bulletin de l'Herbier Boissier*, suspended for a time, appears again, under the direction of M. Gustave Beauverd, curator of the herbarium. The first number of the new series, bearing the date December 29, contains papers on African plants by de Wildeman

[1] Koorders, S. H. Verslag eener botanische denstreis door de Minahasa, tevens eerste overzicht der flora van N. O. Celebes, uit een wetenschappelijk en praktisch oogpunt. Batavia, s'Gravenhage, 1898, xxvi + 716 pp., 10 charts and 3 plates. — Mededeelingen van s' Lands Plantentuin, No. xix.

and Durand, ferns of the Amazon region by Christ, Brazilian fungi by the Sydows, the vegetation of Cape Magoary, etc., by Huber, an alpine variety of *Stellaria nemorum* by Beauverd, and a valerian new to the flora of Savoy by Briquet.

Papers of botanical interest in the *Proceedings of the American Pharmaceutical Association* for 1900 are the following: Merrill and Schlotterbeck, alkaloids of *Bocconia cordata;* Gordin, alkaloids of *Ceanothus Americanus;* Kebler, notes on jalap roots; Kraemer, assay of drugs by the use of living plants; Schneider, pharmaceutical bacteriology; Stevens, wild-cherry bark and its preparations; Dohme and Engelhardt, *Atropa Belladonna* or *Scopola Carniolica;* Schlotterbeck, *Adlumia cirrhosa.*

Under the title of *Torreya* the Torrey Botanical Club of New York City has begun the issuance of a monthly journal of botanical notes and news, under the editorial management of Dr. M. A. Howe.

The self-pruning of certain trees, a subject apparently first discussed in this country by Trelease, in the *Report of the Wisconsin Experiment Station* for 1884, and again by Bessey in *Science* for 1900, receives interesting treatment by Schaffner and Tyler in the *Ohio Naturalist* for January. Figures are given illustrating the process in Populus and Salix.

The *Bulletin of the Torrey Botanical Club* for December contains systematic papers on fungi by Peck, lichens by Zahlbruckner, mosses by Mrs. Britton, fernworts by Maxon, and Rocky Mountain phanerogams by Rydberg.

Part XXIII of *Pittonia* is largely devoted to Compositæ and Cruciferæ, with a decade of new Gentianaceæ, a discussion of some neglected generic types, and a batch of corrections in nomenclature.

Thalictrum confine is the name proposed in *Rhodora* for December, by Mr. Fernald, for a plant of Ontario and Maine, which in habit suggests small-leaved *T. Fendleri,* and he shows that *T. occidentale* extends eastwards so as to reach New Brunswick and Maine.

The systematic value of tendrils in Lathyrus is discussed by Fritsch in the *Oesterreichische Botanische Zeitschrift* for November.

Dr. Robinson, in *Rhodora* for December, discusses the nomenclature of Agrimonia in New England.

Dr. Holm contributes an article on the anatomy and morphology of *Erigenia bulbosa* to the *American Journal of Science* for January.

Taraxacum in North America is increased by Professor Greene, in *Pittonia* for January 5, by the description of *T. Chamissonis*, *T. rupestre*, *T. ovinum*, *T. lacerum*, *T. dumetorum*, *T. mutilum*, *T. angustifolium*, and *T. ammophilum*, all from the Northwest, British Columbia, or Alaska.

Senecio, as it occurs in New England, is revised by Greenman in *Rhodora* for January.

Monarda fistulosa and its allies are passed in critical review by Fernald in *Rhodora* for January.

Professor Kellerman, in *O. S. U. Naturalist*, No. 2, gives an interesting plate of variations in the foliage of *Smilax glauca*.

Professor Scribner and his assistants publish a series of studies on American grasses as *Bulletin 24* of the Division of Agrostology of the United States Department of Agriculture.

The specific or hybrid character of *Asplenium ebenoides* is discussed by Mr. Maxon in the *Botanical Gazette* for December, and, unlike Professor Underwood, he considers the suggestion of hybridity as too patent to be ignored, though he admits the absence of positive proof of it.

A remarkably lobed form of *Asplenium ebeneum* is described by Mr. Davenport in *Rhodora* for January, under the varietal name Hortonæ.

Weinzirl, in the *Journal of the Cincinnati Society of Natural History* for December 28, publishes an account of the air bacteria of the arid region of New Mexico, which leads him to the conclusion that the rather few species found differ from those yet described from other regions.

A compilation of the North American Phyllostictas, with descriptions of the species published up to August, 1900, by J. B. Ellis and B. M. Everhart, has recently been distributed by the authors, and bears the imprint of G. E. Smith, Vineland, N. J.

A paper on a spot disease of the violet, due to *Alternaria Violæ*, by R. H. Dorsett, forms *Bulletin 23* of the Division of Vegetable Physiology and Pathology of the United States Department of Agriculture.

No. 5 of Mr. C. G. Lloyd's *Mycological Notes* is largely concerned with Collybia, as represented about Cincinnati.

Professor Cheney has published "an historical review of the work done on the flora of the territory now included within the limits of Wisconsin," in the *Pharmaceutical Review* for December and January.

The sixth fascicle of de Wildeman and Durand's "Illustrations de la flore du Congo," in course of publication in the *Annales du Musée du Congo*, of Brussels, bears date of September, 1900.

The concluding part of Vol. II, and the first part of Vol. III, of J. Medley Wood's *Natal Plants* have recently appeared.

Dr. Henry Kraemer, in the *Proceedings of the American Pharmaceutical Association* for 1900, proposes the use of living plants in drug assaying, to test the strength of certain toxic solutions. In a series of experiments, seedlings of *Lupinus albus* and *Pisum sativum* were grown in strychnine nitrate, brucine sulphate, and tincture of nux vomica solutions of different strengths. The growth of the radicles was found to be inversely proportional to the toxicity of the solutions.

In the seventeenth *Annual Report* of the Wisconsin Agricultural Experiment Station, Professor Goff has a paper of interest on the development of flower buds on a number of fruit plants, in connection with the temperature curve for March and April, in which their development was found to lie.

Students of leaf-form and position will be interested in a paper by Raciborski in the *Annales du Jardin Botanique de Buitenzorg*, Vol. II, Part I.

"Open Spaces for the People" is the title of an article by Philip MacMahon, curator of the Brisbane Botanic Gardens, in the *Queensland Agricultural Journal* for December, in which a general plan is given of that garden and of promenades that it is suggested may be connected with it.

Some profit and a little amusement may be obtained from an examination of a recent *Consular Report* on "school gardens in Europe," among which Consul-General Lincoln of Antwerp includes the Kindergartens of that city.

A compendious volume of statistics concerning the use of wood pulp in foreign countries is published as Vol. XIX of the *Special Consular Reports* of our Government.

The "Diamond Jubilee Number" of the *Gardeners' Chronicle* for January 5 contains portraits of Lindley, Paxton, Berkeley, and

Darwin, all of whom contributed matter of botanical or horticultural interest to the earlier volumes of the journal, which, though agricultural in name, has always been of interest and value to the botanist.

The double number of the *Botanische Zeitung* (Abtheilung I) for December 1 is devoted to Brunfels, a botanist of four hundred years ago.

The Fern Bulletin for January opens with a portrait of Professor Underwood.

PALEONTOLOGY.

Dean's "Palæontological Notes."[1] — This elaborate memoir of upwards of forty pages, six plates, and eighteen text-figures, is one of the most important contributions to the literature of Devonian Arthrodires that has yet appeared in this country. It has for its twofold object a minute description of the skeletal structures in Mylostoma, Stenosteus, and Selenosteus (the last two being here made known for the first time), and a discussion of the characters and relationships of the whole group of Arthrodires, with the improvision of a new system for their arrangement.

Four of the quarto plates are admirably lithographed by the author from original specimens; the other two are from photographs. Not the least valuable and suggestive feature is the interspersion throughout the text of numerous diagrams showing the arrangement of plates in the cranial, dorsal, and ventral armor of different genera of Arthrodires. Restorations of this nature are not only useful for the graphic information they convey, but they afford an extremely convenient means of comparison. The interesting modifications displayed by Mylostoma and Dean's two new genera, especially as regards their dentition, constitute a welcome addition to our knowledge of this group. Owing to their poor preservation, the difficulty of deciphering the details which the author has painstakingly worked out and skillfully reconstructed must have been very great, and obviously none but an expert could have succeeded.

[1] Dean, Bashford. Palæontological Notes. I, On Two New Arthrodires from the Cleveland Shale of Ohio; II, On the Characters of Mylostoma, Newberry; III, Further Notes on the Relationships of the Arthrognathi. *Mem. N. Y. Acad. Sci.*, vol. ii (1901), pt. iii.

Of more general interest, however, are the author's views as to the relationships of the so-called "Arthrognathi" (= Arthrodira + Anarthrodira, the latter comprising only the genera Macropetalichthys and Holopetalichthys). Excluding them from both Pisces and Ostracoderms, Dean assigns them the rank of an independent class, which he conjectures may have been descended from primitive forms like Lanarkia in the Silurian. The prime reason for removing Arthrodires from Pisces rests upon the interpretation of their jaw-elements, which Dean regards as merely dermal ossifications, showing "not the slightest evidence of their relation to endoskeletal or gill-arch jaws." There is, however, strong presumptive evidence that a cartilaginous mandibular arch was present, the distal portion of which ensheathed the lower dental plate ("gnathal," Dean), and the proximal portion, or suspensorium, was attached to the head-shield. How, for instance, is one able to conceive of the attenuated mandibles of Titanichthys, except as imbedded in tissues corresponding to the Meckelian cartilage?

The author advances some ingenious theories to explain the evolution of the articular joint between cranial and dorsal shields characteristic of Arthrodires, and, giving free rein to his imagination, speculates on how such a joint might have arisen in the head-shield of Macropetalichthys. A slight impediment exists, however, in the way of accepting his conclusions, for the reason that we cannot admit any of his premises. Dean assumes, and so, too, have Newberry, Cope, and Eastman before him, for that matter, that a valid basis of comparison exists between this enigmatical form and various specified genera, where the facts prove such is not the case; also that the arrangement of cranial plates and sensory canals in the genus under consideration is homologous with that pervading Arthrodires generally, which is an egregious error.

The fact of the matter is that all writers on Macropetalichthys have been misled by deceptive appearances, perhaps to some extent also by preconceived ideas, and its osteology has not yet been correctly interpreted. Eastman's and Dean's suggestion that there is a superficial system of investing plates arranged independently to a distinct substratum of bony elements is unsubstantiated, if not disproved; and still more improbable is the notion that the "head-shield" is made up of combined cranial and dorsal shields. The transverse septum peculiar to this genus is an internal structure situated a long distance in advance of the posterior cranial border, and recalling in a measure the inwardly directed processes on the

inferior aspect of the postorbital in Dinichthys. There are in Macropetalichthys no movable ginglymoid joints, neither dorsal nor ventral armor so far as known, and apparently no ossified lower jaw. In short, this genus and the accompanying Asterosteus are as far removed from Arthrodires as are the Ostracoderms, and should perhaps be included in the same subclass with the latter. Their canal systems and cranial plates can be no more homologized with those of Arthrodires than with Stegocephalians, and the most we can affirm is that their arrangement is bilaterally symmetrical, and in a few respects similar or paralleled. Dean's text-figures 12 and 13 are objectionable, therefore, in so far as they depict merely fanciful conditions; and in Figs. 15 and 16 the overlap of the clavicular is shown, but the plate itself is omitted.

Apart from this parenthetical discussion, as it were, of extraneous genera, the author's generalizations respecting Arthrodires, his subdivision of them into several new families, and summary of their characters, reflect the advanced ideas of an investigator who has greatly enlightened us as to their structure and interrelationships.

C. R. E.

Jurassic Fossils from Alaska.[1] — In this paper Dr. Pompeckj has given a revision of all the known Jurassic fossils of Alaska and has described a number of new forms. According to Dr. Pompeckj the Lias is represented at Kialagvik, or Wrangell Bay, on the Peninsula of Alaska, as shown by the presence of *Amaltheus whiteavesi* White, *Lillia howelli* White, *L. kialagvikensis* White. This fauna was described by Dr. C. A. White as of Upper Jurassic or Lower Cretaceous age.

The Kelloway stage of the Middle Jurassic is represented at Katmaiskoj on the southeastern side of the Alaskan Peninsula, and on the northwestern side of the Kadiak Island. The former locality furnished the following fossils :

Cadoceras wosnessenski Grewingk, *C. grewingki* Pompeckj, *C. catostoma* Pompeckj, *Belemnitella, sp.* indet., *Aucella, sp.* indet., *Inoceramus, sp.* indet. The locality on Kadiak Island yielded the following fossils: *Phylloceras subobtusiforme* Pompeckj, *Cadoceras* conf. *wosnessenski* Grewingk, *C. grewingki* Pompeckj, *C. Schmidti* Pompeckj, *C. petelini* Pompeckj, C., *sp.* indet., *C. stenoloboide* Pompeckj. These fossils show a wide distribution of the sea during the Kelloway stage

[1] Pompeckj, J. F. Jura-Fossilien aus Alaska, *Verhandl. Kais. Russ. Mineralog. Gesell. St. Petersbourg*, Ser. 2, Bd. xxxviii (1900), Nr. 1.

of the Middle Jura, but the occurrence of Lias in the same region shows that Neumayr's hypothesis of a great transgression of the sea in Middle Jurassic time in the arctic region will not hold good. Marine deposits existed there even before Jurassic time, as shown by the occurrence of Upper Triassic deposits in Alaska.

J. P. S.

The Permian of Armenia.[1] — The strata of Djulfa in Armenia are classic in geological literature, having long ago been assigned to the Subcarboniferous on account of the supposed occurrence of *Goniatites striatus*. But a revision of the fauna, based on a new collection made by Prof. F. Frech, shows that these beds belong to the Permian, for there is a mixture of Paleozoic and Mezozoic types. Their Paleozoic age is shown by the occurrence of typical Permian brachiopods, such as are known in Russia and India, and of the goniatite genus Gastrioceras, which has never been found above the Permian. On the other hand, the genera Hungarites and Otoceras are known there, which elsewhere are not found below the Trias. The evolution of Hungarites from the simple forms of Armenia into the complex development as known in the Trias of Siberia and India is worked out by Dr. von Arthaber in a most convincing manner, and is a good argument against useless multiplication of generic names in a phylogenic series.

J. P. S.

Notes. — Dr. Diener (*Beitr. Palaeontol. Oesterreich-Ungarns*, Bd. XIII, 1900) has continued his detailed studies of the Triassic faunas in this contribution, treating of the Muschelkalk zone of *Ceratites trinodosus*. He describes a new genus, Arthaberites, of the family Pinacoceratidæ, resembling Pseudosagoceras Diener of the Lower Trias of Siberia, and possibly descended from it. The fauna described shows a strong resemblance to that of the Bosnian Muschelkalk long since made known by the works of F. von Haner. It consists of numerous species of Ceratites, Anolcites, Celtites, Proarcestes, Joannites, Procladiscites, Megaphyllites, Sageceras, Arthaberites, Pinacoceras, Norites, Monophyllites, Sturia, Gymnites, Ptychites, Nautiius, Orthoceras, Atractites. Many of these species had not before been found in the Alps, and their discovery is of material aid in correlating the Alpine strata with those of the other Triassic provinces.

[1] Arthaber, G. von. Das jüngere Palaeozoicum aus der Araxes-Enge bei Djulfa, *Beiträge zur Palaeontologie Oesterreich-Ungarns und des Orients*, Bd. xii (1900), Nr. 4.

Dr. Whiteaves (*Geol. Survey of Canada*, Vol. I, Part IV) revises his published papers on the paleontology and stratigraphy of the Queen Charlotte Islands, many old species being renamed, as further studies have shown their designations to be untenable. Several new species of brachiopods and Mollusca have been obtained by later collectors and are added in this paper. Among the ammonites may be noted the predominance of Desmoceras and Olcostephanus, also the absence of Baculites and Pachydiseus, which are characteristic of the Cretaceous of Vancouver Island. The faunas here described seem to include both Knoxville and Horsetown beds of the Californian section, as shown by such characteristic species as *Phylloceras knoxvillense* Stanton, *Lytoceras batesi* Trask, *L. sacya* Forbes, *Desmoceras breweri* Gabb, *D. haydeni*, and *Aucella crassicollis* Keyserling.

The revision of the nomenclature will be exceedingly acceptable and useful to students of West-Coast stratigraphy.

Dr. Sokolow (*Mem. Comité Geol. St. Petersburg*, Vol. IX, No. 5, 1899) has made an interesting study of the brackish-water basin fauna that lies immediately between the Mediterranean stage of the lower Miocene and the Sarmatic stage of the middle Miocene Tertiary of Russia. The Mediterranean stage represents the deposits of the disappearing ancient Mediterranean Sea, and the Sarmatic beds are the deposits of the ancient Black Sea. In this paper we have a study of the fauna transitional between the two epochs and the two basins. In consequence of this the fauna is a mixed one, showing both marine and brackish-water types, due to the rapidly changing physical geography and the development of the extensive brackish-water seas that covered southern Russia in later Miocene time.

Most students of the Triassic paleontology of the Alps occupy themselves with the cephalopods, while the other groups are neglected. But Dr. Kittl (*Ann. k. k. Naturhist. Hof-Museum, Wien*, Bd. XIV, Nr. 1, 2) has given an elaborate revision of the gastropods of the classic St. Cassian beds of the southern Alps, describing many new species and making known a rich fauna. The detailed stratigraphy and correlation of these beds are taken up, and much new light is thrown on the relations of the various fossiliferous horizons of the southern Alps.

In the *Bulletin* of the Harvard Museum of Comparative Zoölogy Mr. C. R. Eastman gives descriptions and figures of two species of extinct gar pikes, *Lepidosteus atrox* Leidy and *L. simplex* Leidy, from

the Eocene Green River shales of Wyoming. Most of the fossil gar pikes of America have been hitherto known from bare fragments scantily described. Mr. Eastman's specimen of *L. atrox* is especially complete, as large as an alligator gar, and very much like it in appearance. In fact it "lacks any positively archaic features," and Mr. Eastman regards it as "obviously the direct progenitor of the alligator gar, *L. Tristœchus.*" Mr. Eastman finds no trace of the earlier ancestry of Lepidosteus. The gar pikes "blossom forth suddenly and fully differentiated at the dawn of the Tertiary without the least clue to their ancestry, unheralded and unaccompanied by any intermediate forms, and they have remained essentially unchanged ever since."

In the *Bulletin* of the Kansas University, Vol. I, No. 2, Prof. S. W. Williston describes and figures many teeth of sharks found in the Cretaceous rocks of Kansas, his paper being a very useful contribution to this difficult branch of paleontology. In the matter of nomenclature, apparently, Agassiz's name, Oxyrhina, should not be used instead of the earlier Isurus of Rafinesque, and Scylliorhinus of Blainville has unfortunately clear priority over Scyllium Cuvier.

PETROGRAPHY.

Geology of the Black Hills. — Irving's contribution to the geology of the Northern Black Hills adds a great deal to our knowledge of this interesting region, especially from the point of view of petrography. The author agrees with Crosby, rather than with Russell, in regarding the larger intrusives of the district as laccolites and not as plugs. He finds also an abundance of sills and dikes. The dikes characterize the Algonkian slates, the sheets and laccolites the Cambrian shales. The Carboniferous limestone is almost devoid of intrusions of any kind. The principal types of rocks recognized are a quartz-ægirite-porphyry, tinguaite, phonolite, trachytoid-phonolite, quartz-porphyry, mica-diorite-porphyry, dacite, tonalite, and augite-vogesite. The phonolites and quartz-porphyries are the most abundant types, with the quartz-ægirite-porphyries and the diorite-porphyries fairly abundant. There is such an intimate gradation between the different types that they appear to be related genetically. In the pre-Cambrian rocks, dikes and possibly plutonic

intrusions of basic igneous magmas took place before the metamorphism of the Algonkian sediments.

The author does not agree with Van Hise in ascribing the crystalline character of the schists near Deadwood to the agency of intrusives. He regards the metamorphism as "dynamic" rather than "contact."[1]

Isle Royale and Keweenaw Point Volcanics. — In Vol. VI of the Michigan Survey, Lane[2] and Hubbard[3] give a great many interesting details concerning the petrography of the Keweenawan eruptives.

One of the most interesting features of Lane's paper is his discussion of the cause of the variation in coarseness of grain in rocks, and the application of his conclusions to the problem of the nature of the Isle Royale and other rock-sheets. From the fact that the Isle Royale sheets are characterized by an increase in the size of grain to their centers, he concludes that they are surface flows or lavas. On the other hand, he concludes that Lawson's view as to the intrusive character of the diabase sheets in the Huronian beds of the north shore of Lake Superior is confirmed by the fact that they are characterized by a rapid variation in size of grain for the first few feet from their contacts with the surrounding rocks, and then by a central coarser belt of tolerably uniform grain.

Another interesting chapter in the report is that on the differences in structure between small intrusive basic masses and their corresponding effusive forms. To the already recognized distinctions between these two forms of igneous rocks, Lane adds that the miarolitic cavities in intrusive masses naturally become filled with other minerals than the zeolitic and chloritic ones characterizing the corresponding pores in effusive rocks. Among the most important of these minerals is quartz, which often appears in diabase dikes as micropegmatitic intergrowths in the central portions of their masses. The microscopic and chemical features of the Isle Royale lavas are described in some detail.

The report by Hubbard deals mainly with the structural problems presented by the interbedded lavas and sandstones in Keweenaw Point. It contains a few notes in the petrography of the various lava beds.

[1] *Ann. New York Acad. Sci.*, vol. xii, p. 187.

[2] Lane, A. C. Geological Report on *Isle Royale, Michigan. Geol. Survey of Michigan*, vol. vi, pt. i.

[3] Hubbard, L. L. Keweenaw Point, with Particular Reference to the Felsites and their Associated Rocks, *ibid.*, vol. vi, pt. ii.

Occurrences of Differentiated Magmas. — As the result of a rapid survey of the Magnet Cove, Arkansas, igneous area, Washington[1] concludes that the complex described by Williams represents an excellent though peculiar example of a highly differentiated magma, probably in the form of a laccolite, and not a series of independent intrusions. The rock types present in the area form a regularly graded series, ranging from foyaite, through leucite-porphyry, shonkinite-porphyry, ijolite, and biotite-ijolite to jacupirangite. The distribution of the rocks is, however, abnormal, since the basic varieties are near the center of the supposed laccolite, and the acidic varieties in its periphery. The author explains this abnormality by supposing the magma to be a solution in which the solvent was in great excess. This solidified first on the outside, leaving a more concentrated, and consequently a more basic solution within. The solvent continued to separate by crystallization as a more and more basic rock, as the cooling continued inward, until, finally, at the center the most concentrated and most basic material solidified as jacupirangite.

Spurr[2] has compared the order of succession of the intrusions in the Great Basin and has found it to be in general the same throughout the district, although at any given place certain members of the series may be lacking. This succession as worked out is as follows: acid rocks (rhyolites), siliceous intermediate types (andesites), acid rocks, associated with basalts, basic intermediate types (more basic andesites and aleutites), basic rocks (basalts), with associated rhyolites. The Great Basin appears to have been underlaid by a single body of molten magma which supplied at different times lavas of similar composition to all the different parts of the overlying surface. Since this succession is different from any described from other regions, the author suggests that the first rhyolite is the end member of a series of differentiates, and that the andesites are the beginnings of two distinct cycles of differentiation. He further suggests that during the first completely recorded cycle beginning with the earlier andesite the siliceous differentiates of this magma were erupted in preference to the basic differentiates, while in the second cycle the basic members were the predominant extravasations. It must be borne in mind that the processes of differentiation are independent of the causes that produce expulsion of lavas, and hence the records of the differentiation, as observed on the

[1] *Bull. Geol. Soc. Amer.*, vol. xi, p. 389.

[2] *Journ. of Geol.*, vol. viii, p. 621.

surface, must necessarily be incomplete. For this reason the succession of lavas in any district should be studied with reference to its general features rather than to its details, and care must be taken to exclude from the discussion the intermediate rocks formed by mixing of the different types.

The great batholite forming the height of land between the highland mountains south of Helena and Butte, Montana, is composed of rocks presenting a wide variation in composition.[1] The main rock is a hornblende-granite (I) resembling closely a quartz-monzanite. At Butte the rock is a little more basic (II). Great masses of aplite (III), possessing often a lenticular shape, are associated with the granites, perhaps as a differential product of the hornblende-granite, the Butte granite being the more basic differentiate. At the periphery of the batholite basic dikes penetrate the surrounding sedimentaries.

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	K_2O	Na_2O	H_2O	Various	Tot.
I.	67.12	.48	15.00	1.62	2.23	3.43	1.74	4.52	2.76	.67	.31	= 99.88
II.	64.03		15.58	1.96	2.83	4.20	2.15	4.11	2.76			
III.	77.05	.12	12.84	.56	.14	.57	tr.	5.52	2.81	.70		= 100.31

As the result of his studies on the igneous rocks of the Bohemian Mittelgebirge, Hibsch[2] concludes that the succession is as follows: (1) flows of basalt, preceded by phonolite in a laccolite mass, (2) flows of tephrites, stock intrusions of essexite, dikes of camptonite, monchiquite, bostonite, gauteite, and sodalite-porphyry, (3) basalts, trachytes, phonolites, and dikes of tinguaite and eleolite-porphyry.

Hackman[3] has reëxamined the ijolite in the Parish of Kunsamo, Finland. He finds the main portion of the several massifs to consist of the normal rock (I), but in addition to this he recognizes also the following as differentiation products — a nepheline-rich ijolite (II), a soda sussexite (III), a magnesian essexite (IV), and a pyroxene-syenite which may, however, be a rock formed by the solution of the granite surrounding the igneous rock in the magma of the latter.

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	CaO	MgO	Na_2O	K_2O	P_2O_5	Total
I.	42.89	1.05	19.45	3.34	3.09	.39	10.99	3.74	10.03	2.17	1.54	= 98.68
II.	43.02	.63	24.63	3.59	2.17		5.47	1.96	14.81	2.99	.70	= 99.97
III.	47.43	.10	23.60	4.59	1.20		4.42	.67	15.08	2.00		= 99.09
IV.	45.66	2.75	11.64	3.57	10.61		9.11	11.08	2.60	.44	.26	= 99.92

[1] Weed, W. H. *Journ. of Geol.*, vol. vii, p. 737.
[2] *Min. u. Petrog. Mitth.*, Bd. xix, p. 488.
[3] *Bull. Com. Geol. d. Finlande* (1900), No. 11.

Graphic Representation of Rock-Analyses. — Müggs[1] proposes a scheme for the graphic representation of the chemical composition of rocks based on Brögger's and Michel-Lévy's scheme. The relative percentages of the various metallic constituents are indicated by means of polygons drawn through points plotted on eight radii. Within this is a second polygon which represents the silica content. The size of the latter is determined by the percentage of this constituent present, and the relative sizes of this polygon and the outer one are an indication of the rock's acidity. In constructing the inner polygon the percentage of silica present is divided into eight equal parts, and each is plotted in one of each of the radii. In plotting for the outer polygon the Al_2O_3 is divided into three parts determined by the proportion borne by K_2O and Na_2O to one another and the other bases.

The Origin of the Glaucophane-Schists. — Rosenbusch, as is well known, has hitherto suspected that true glaucophane-schists are genetically associated with sedimentary rather than with igneous rocks, but so few analyses of these schists have been made that the supposition has not been capable of chemical investigation. In a recent[2] article, however, he shows that some of the schists have the composition of a normal gabbro magma. In these epidote, zoisite, lawsonite, prehnite, margasite, and garnet are usually if not always present. Rocks of this kind are closely related to amphibolites. Other glaucophane-schists he still believes to be metamorphosed sediments, but analyses of these are lacking.

Washington[3] supplements Rosenbusch's investigations in an article in which he records and compares fifteen analyses of these schists. Upon comparing their analyses he discovers that the rocks fall into two main groups, a very basic group with a content of SiO_2 varying between 46% and 49.7% and a very acid group with SiO_2 between 74.5% and 82.5%. The former he believes, with Rosenbusch, to be derived from gabbros, diabases, or their tuffs. The acid glaucophane-schists he thinks are derived from cherts, quartzose shales, or quartzites. The basic forms scarcely differ from the amphibolites in chemical composition, the formation of the one or the other kind of schists depending probably upon conditions of metamorphism.

[1] *Neues Jahrb. f. Min.* etc., Bd. i (1900), p. 100.
[2] *Sitzb. kön. preuss. Ak. Wiss. Berlin*, Bd. xlv (1898), p. 716.
[3] *Amer. Journ. Sci.*, vol. xi (1901), p. 35.

CORRESPONDENCE.

Editor of the American Naturalist:

Sir, — In his valuable paper on "the Snakes of New York State," in the February number of the *Naturalist*, Dr. Eckel enumerates two forms as doubtfully occurring in the state upon the authority of Cope who, in his *Crocodilians, Lizards, and Snakes of North America*, records specimens as being in the collection of the National Museum. Dr. Eckel properly doubts the correctness of the statements, and I am in a position to corroborate him.

The first is a specimen of *Osceola doliata clerica*, United States National Museum, No. 1407. The value of the locality "New York" may be inferred from the fact that the specimen was received in 1858 from the Museum d'Histoire Naturelle in Paris, together with No. 1405, *Elaps lemniscatus*, and No. 1406, *Dromicus cursor*, — all three said to have come from New York. It is simply a case of French geography.

The other case is that of a *Natrix fasciata erythrogaster*, United States National Museum, No. 9984, said to have come from Westfield Falls, Conn. In this case the geography is correct enough, but the identification is wrong. I have just examined the specimen; it is a *Natrix sipedon* pure and simple!

Thus Dr. Eckel may safely eliminate Nos. 10 and 13 from his "check list."

Leonhard Stejneger.

U. S. National Museum,
February 15, 1901.

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